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Exploring Science BROWN BOOK

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(Acknowledgments continued on page 288)

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CONTENTS

Pages

Unit 1 Plant Growth and Behaviour 6–47

Chapter

1 Plant beginnings 8–21
2 Plant behaviour and nonliving things 22–29
3 Plant behaviour and living things 30–43
Workers Who Use Science 44
Reviewing the Main Ideas 45
Reading About Science 45
Testing for Understanding 46
Having Fun with Science 47

Unit 2 Animals and Their Environment 48–95

Chapter

1 Where have all the dinosaurs gone? 50–57
2 How are animals suited to where they live? 58–68
3 How do animals protect themselves? 69–78
4 What can people do to protect animals? 79–91
Workers Who Use Science 92
Reviewing the Main Ideas 93
Reading About Science 93
Testing for Understanding 94
Having Fun with Science 95

Pages

Unit 3 Work and Machines 96-143

Chapter

1 Work, work, and more work! 98–103
2 Simple machines 104–125
3 Teams of machines 126–131
4 Why work at all? 132–139
Workers Who Use Science 140
Reviewing the Main Ideas 141
Reading About Science 141
Testing for Understanding 142
Having Fun with Science 143

Unit 4 Solids, Liquids, and Gases 144-191

Chapter

1 It's a matter of molecules 146–151
2 The states of matter 152–162
3 Changing the states of matter 163–174
4 Other changes in matter 175–187
Workers Who Use Science 188
Reviewing the Main Ideas 189
Reading About Science 189
Testing for Understanding 190
Having Fun with Science 191

Pages

Unit 5 Air and Weather 192–239

Chapter
1 The air around you 194–200
2 What makes up weather? 201–211
3 What's the weather going to be like? 212–224
4 Stormy skies 225–235
Workers Who Use Science 236
Reviewing the Main Ideas 237
Reading About Science 237
Testing for Understanding 238
Having Fun with Science 239

Unit 6 Watching the Sky 240–281

Chapter
1 A sky full of stars 242–250
2 A special star 251–256
3 The planets 257–271
4 The moon 272–277
Workers Who Use Science 278
Reviewing the Main Ideas 279
Reading About Science 279
Testing for Understanding 280
Having Fun with Science 281

Glossary-Index 282–287

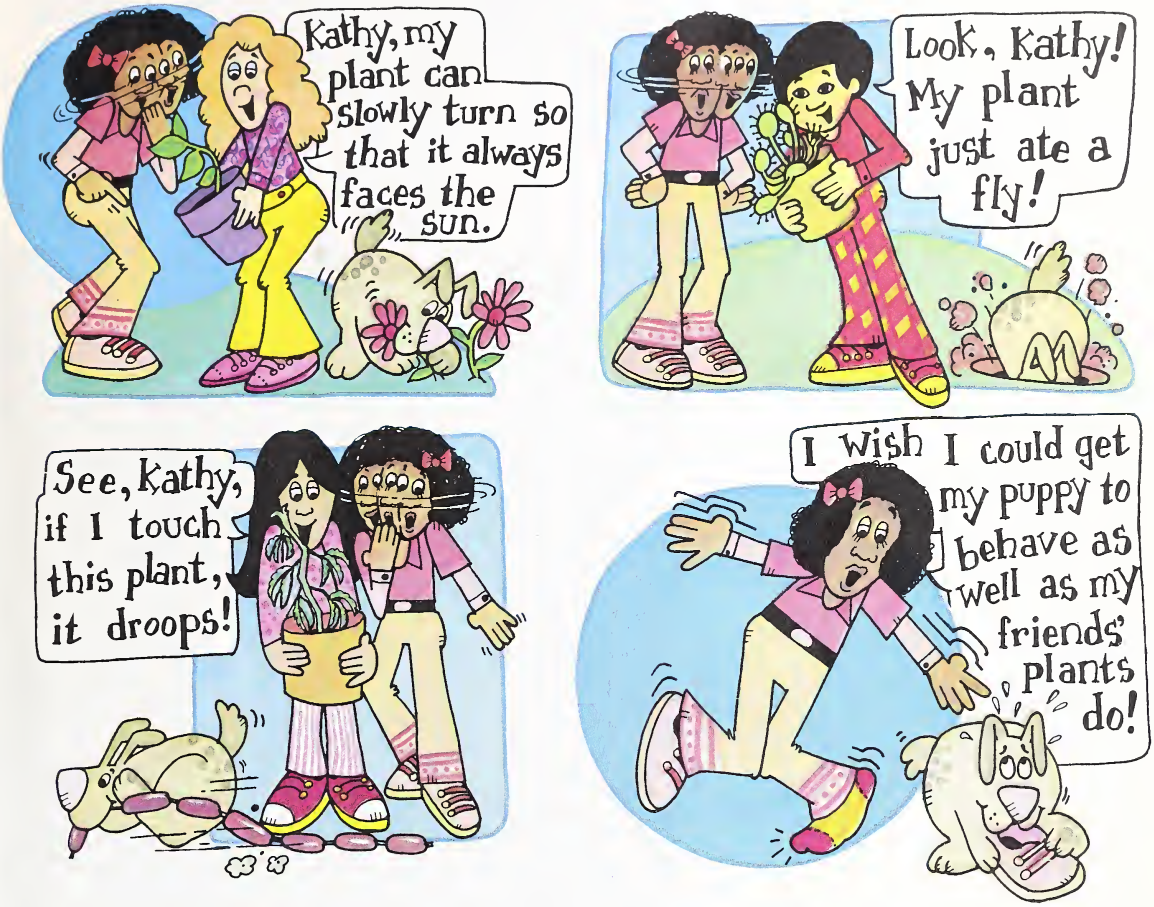
1 Plant Growth and Behaviour

1 Plant beginnings

2 Plant behavior and nonliving things

3 Plant behavior and living things

Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see pages T12–T13 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit and have the pupils begin collecting these materials. These activities are found on pages 11, 12, 21, 23, 27, 28, and 38.


Kathy, my plant can slowly turn so that it always faces the sun.
Look, Kathy! My plant just ate a fly!
See, Kathy, if I touch this plant, it droops!
I wish I could get my puppy to behave as well as my friends' plants do!

What is making each plant behave as it is behaving?[1]

What are some other ways plants behave?[2]

What plant behaviour have you seen?

Introducing the unit: You may wish to have the pupils read the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:

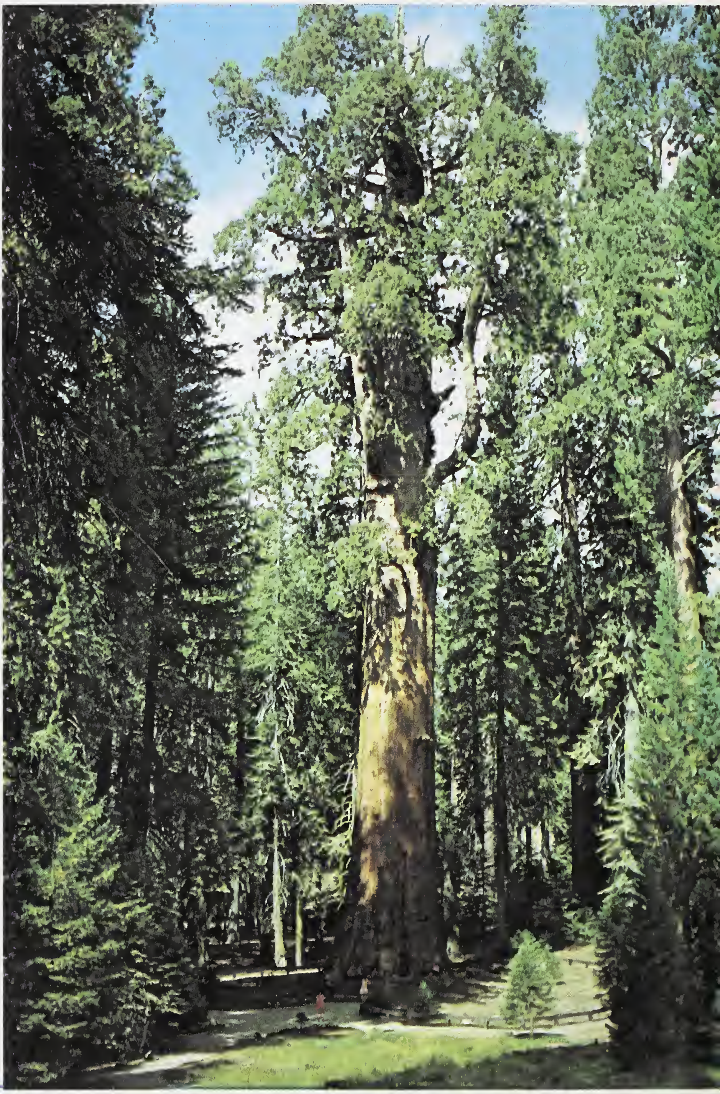
[1] Something around the plant: the sun, a fly, a person.

[2] The roots of plants grow toward water, and plants wilt when the weather is very dry.

1 Plant beginnings

Think of all the plants you see around you each day. You may have noticed that plants have many sizes and shapes. Some plants are small enough to be grown in pots. Others are so large that people seem like ants beside them! What are the shapes of some of the plants you have seen?[1]

[1] **Sample answer:** Some are round, some are triangular, and others are flat.



Main concepts of the chapter (pages 8–21):
Most plants begin to grow from a spore or a seed.
Plants are made up of tiny units called cells.
Plants grow when their cells grow larger and when their cells divide into new cells.
Seeds and spores need water, air, and warmth to sprout.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—recognize the parts of a seed;
—recognize the spore-forming parts of some plants;
—list the parts of a plant cell and their functions;
—state three things seeds and spores need to sprout and grow.

Important words: seeds, spores, seed coat, seed leaves, new plant, cells, microscope, nucleus, chlorophyll, cell wall, carbon dioxide.

Suggested activity: After discussing the paragraph on page 8, you may wish to take a walk with the pupils through a park to observe the variety of plants there. If possible, it would be worthwhile to have the pupils visit a plant conservatory either at the beginning of this unit or after they have learned more about plant behaviour.

Seeds and spores

Although plants have many sizes and shapes, most plants begin to grow in one of two ways. Some grow from *seeds*. Others grow from tiny plant parts called *spores* [SPOH(UH)RZ].

For You to Think About

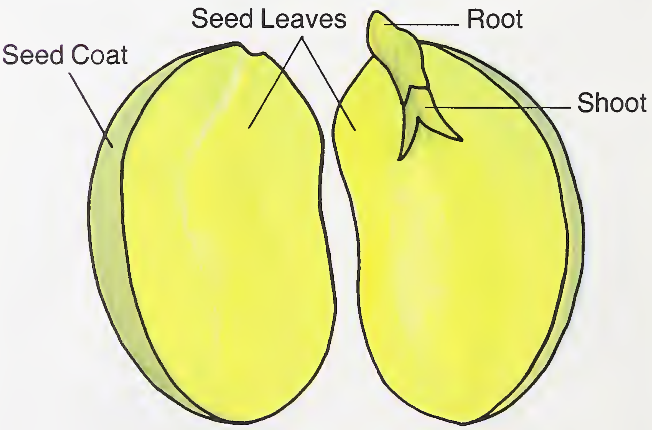
Besides peanuts, people eat many other kinds of seeds. What are some other kinds of seeds you know of that people eat? What kinds of seeds do you like to eat?

Looking at seeds. Have you ever eaten roasted peanuts? The peanuts that people like to eat are really peanut seeds. These peanut seeds are sometimes inside a shell. Each seed has a brown cover called the *seed coat*. All seeds have a seed coat. How do you think a seed coat is helpful to a seed? [1]

[1] **Sample answer:** It protects the seed.

A peanut seed can easily be broken into two pieces. These pieces are called *seed leaves*. Some seeds, like corn seeds, have only one seed leaf. At the end of one of the seed leaves in the peanut you can see the *new plant*. It has the beginning of a tiny root and a tiny shoot. In a growing peanut seed, the shoot becomes the stem and leaves. The

PEANUT SEED



Sample answer for "For You to Think About": Peas, lima beans.

Suggested discussion: After discussing "Looking at seeds," you may wish to ask the pupils why the "seed leaves" are so called. (Sample answer: Because they have food for the growing seedling, just as leaves do for the growing plant.) The seed leaves do not make food, but they do store food to be used by the new plant when it starts to sprout. The pupils eat the stored food in the seed leaves when they eat peanuts.

seed leaves have lots of food for the new plant. Why do you think it is important that the seed leaves have this food? [1]

Although a roasted peanut has all the parts of a seed, it cannot grow. Why do you think this is so? [2]

[1] **Sample answer:** So that the young plant will have nourishment until it can make its own food in its leaves.

[2] **Sample answer:** Because the living plant would have been killed when the peanut was roasted.

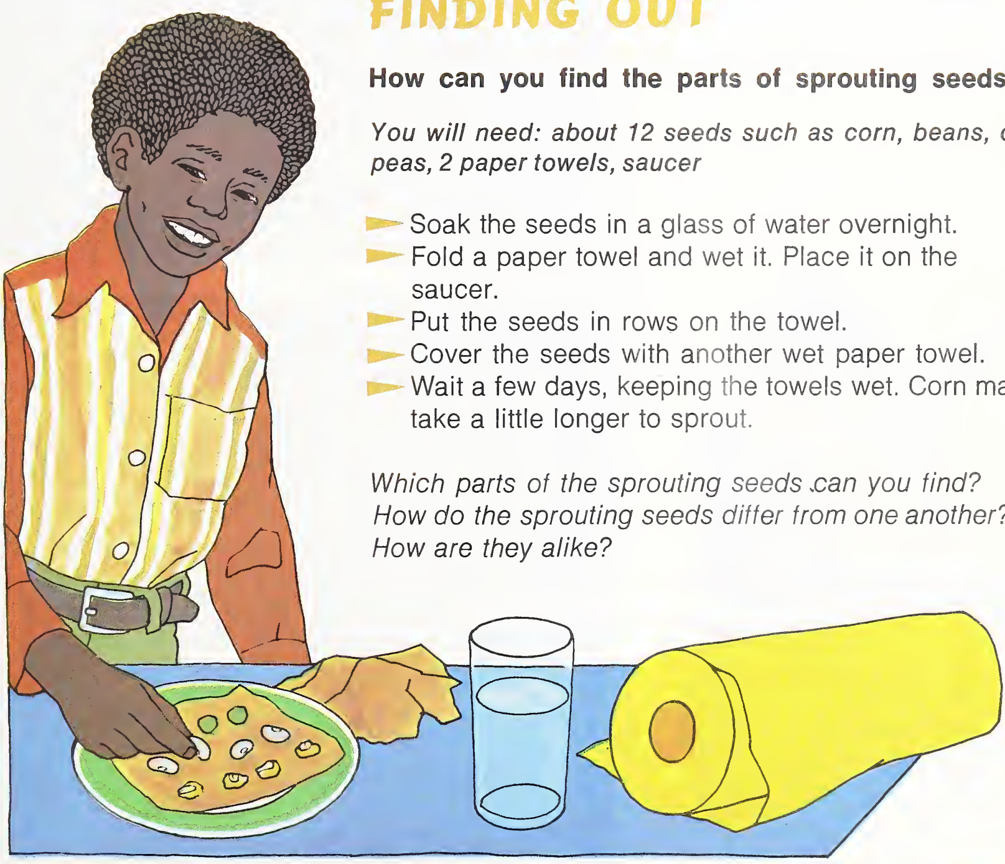
FINDING OUT

How can you find the parts of sprouting seeds?

You will need: about 12 seeds such as corn, beans, or peas, 2 paper towels, saucer

- Soak the seeds in a glass of water overnight.
- Fold a paper towel and wet it. Place it on the saucer.
- Put the seeds in rows on the towel.
- Cover the seeds with another wet paper towel.
- Wait a few days, keeping the towels wet. Corn may take a little longer to sprout.

Which parts of the sprouting seeds can you find? How do the sprouting seeds differ from one another? How are they alike?



Teaching helps for "Finding Out":
Processes used: observing, classifying, comparing, communicating.
Sample findings: The pupils will most likely notice the sprouting root first. Then they will see the sprouting shoot. Some seeds, like beans, have two seed leaves. Other seeds, like corn, have only one seed leaf. The seeds are alike in that all have "new plants" in them that sprout as young roots and young shoots.
Additional information: The seeds in the experiment had been in a dormant, or inactive, state. But when the seeds take in water, their cells become active. Dry seeds can survive without sprouting over relatively long periods of time.

Looking at spores. Have you ever seen small brown dots on the back of fern leaves? Spores are formed inside these brown dots. If a spore falls to the ground, it may grow into a new fern plant. Mushrooms and mosses are other plants that grow from spores.

Unlike seeds, spores do not have a seed coat. Spores do not have seed leaves either. So spores have much less stored food inside them. But plants which make spores may make a great number of them. One plant may make a million spores! Why might this be important? [1]

[1] **Sample answer:** Because spores have very little stored food and no protective covering, very few of them survive. Making many spores ensures the survival of some.

FINDING OUT

What do the spore-forming parts of ferns look like?

You will need: fern leaves collected in late summer or early fall, hand lens

- Collect some fern leaves with brown dots on them. Try to get different kinds of ferns.
- Look at the brown dots on the leaves. These are the spore-forming parts. (The spores are too tiny to be seen without a microscope.)

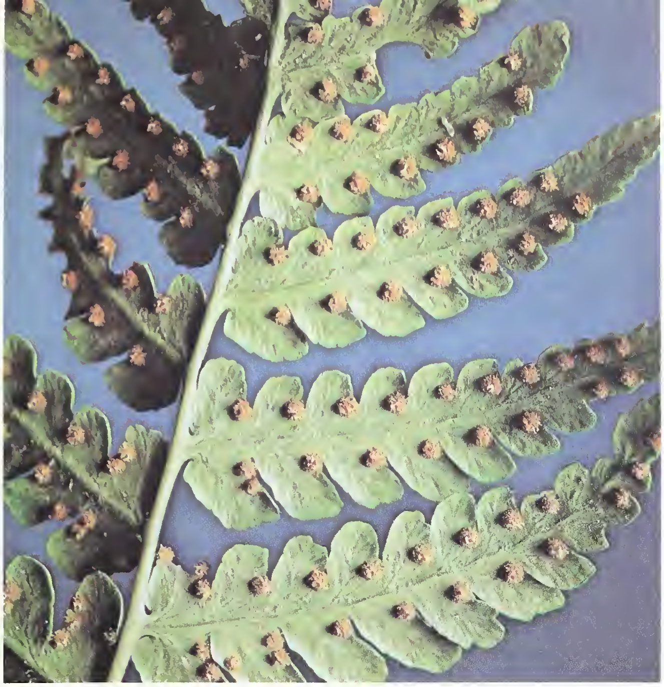
Where on the leaves are the spore-forming parts? What shape do the spore-forming parts have?

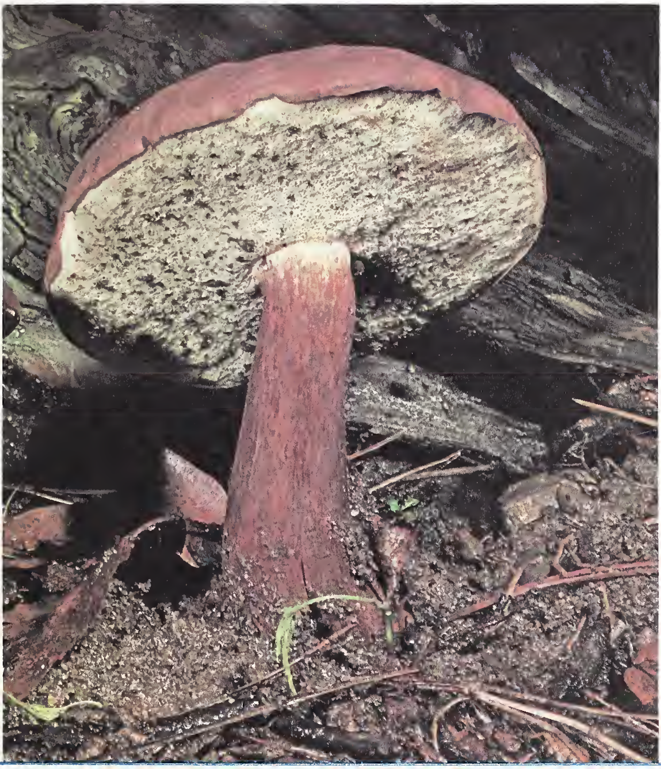
Teaching helps for "Finding Out":

Processes used: observing, comparing.

Sample findings: The pupils will most likely notice a variety of positions and patterns for the spore-forming parts on the fronds, or leaves. Some form borders along all the edges of the fronds. Some line the top borders only. Others form brown dots, lining up double file on the fern fronds. Some of the spore-forming parts are circular in shape; others are linear.

Additional information: You can try pressing the fertile fronds in a plant press or simply in newspapers under heavy books. Change the newspapers every day or so to keep removing the moisture. Once the fronds are dried out, they will last indefinitely.





The brown dots on the fern leaves contain clusters of spore cases, which hold spores. The gray, dust-like spores of the mushroom come from the underside of its cap. Why do you think both plants have their spore-forming parts open to the air?

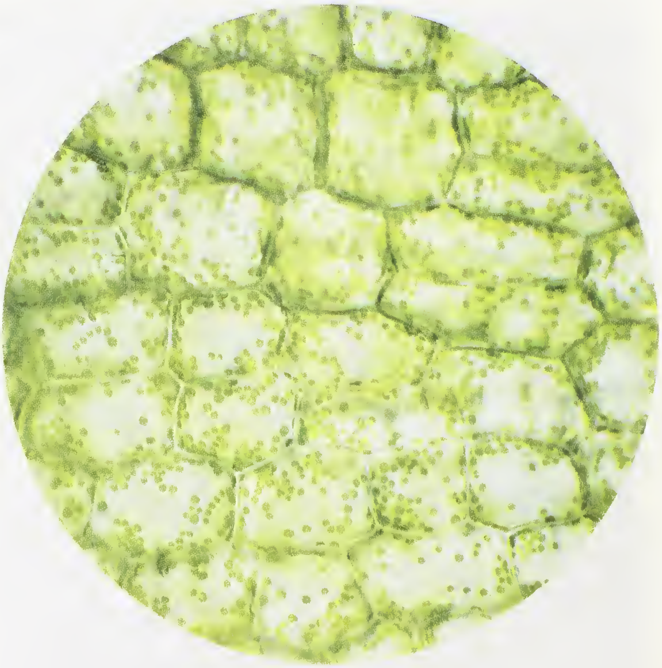
Teaching helps for the picture above: The pupils may wish to look at the spore-forming parts of different kinds of mushrooms. The type pictured above is a porous type, and the spores come out of tiny pores in the undersurface of the cap. Many mushrooms have thin ridges known as gills under the cap. The spores form all along the gills. **Sample answer for the caption:** Because many spores are carried far away by the wind.

Plant cells and growth

Seeds, like all living things, are made up of tiny units of living matter called *cells*. Spores are made up of just one cell each. To understand how plants that come from seeds or spores grow, you need to know some things about plant cells.

What are plant cells like? Plant cells are too tiny to be seen without a *microscope* [MY-kruh-SKOHP]. The picture on this page shows what plant cells look like through a microscope.

A plant cell is made up of many things. Most of the cell is made up of a jellylike matter. This jellylike matter is living. It grows and uses food like other living things do.



These plant cells are shown hundreds of times their normal size. Using the drawing on the next page, what parts of these cells can you find?

Sample answer for the caption: Chlorophyll, cell wall, and cell cover.

Teaching helps for the picture above: The pupils will most likely not see the nucleus in any of the cells in the picture above because special staining is necessary for the nuclei to be visible.

The most important part of the jellylike matter is the *nucleus* [N(Y)OO-klee-uhs]. The picture on this page shows what the nucleus of one plant cell looks like. The nucleus controls the growth of the cell.

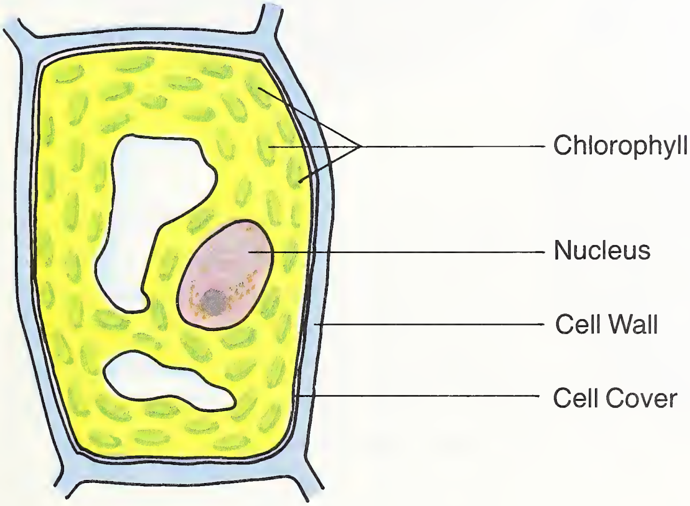
You can also see small green dots in the picture of the plant cell. They hold the *chlorophyll* [KLOHR-uh-fihl]. Chlorophyll is what makes green plants green. What parts of green plants have cells with chlorophyll?[1] How do you know?[2]

A plant cell has a thin, living cover. This cover lets things like water and oxygen pass in and out of the cell. Just outside this cover is another cover called the *cell wall*. It also lets things pass in and out of the cell. The cell wall is thick. It gives the cell its shape.

[1] **Sample answer:** Leaves and stems.

[2] **Sample answer:** Because they are green.

PLANT CELL

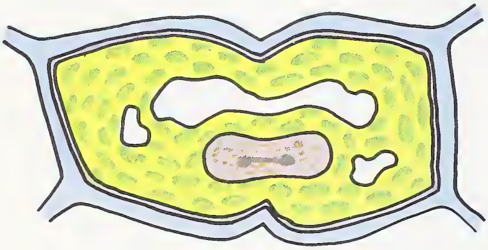


Teaching helps for the picture above: Try to help the pupils visualize that the cell has three dimensions. The cell also has depth which has not been shown in the picture. The label "chlorophyll" applies to the contents of the green "footballs." The "footballs" are known as chloroplasts.

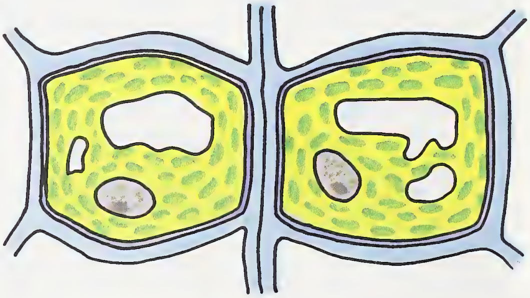
Suggested activity: After discussing "What are plant cells like?" your pupils may wish to make model cells. They can use tiny, clear plastic boxes (such as those in which straight pins are sold). They can use appropriately coloured modeling clay for the nucleus and for the chloroplasts.

What do plant cells do? Have you ever watched a plant grow from day to day? If so, you know that as it grows, the plant changes in many ways. It grows taller. It may grow many leaves. It may grow flowers after a time.

All these things happen because of the cells of the plant. First, each cell grows bigger. So the plant grows bigger. Then, each cell divides into two new cells. These new cells then grow and divide. Each new cell keeps growing and dividing into new cells. This is another way the plant grows bigger.



Plant Cell
Beginning to Divide



Plant Cells
After Dividing

Another thing some cells of green plants do is make food. The food the plant makes is a kind of sugar. Plant cells need chlorophyll to make this sugar. And chlorophyll must have light to work. When plant cells make food, they use water that the roots take in. They also use *carbon dioxide* [dy-OK-SYD], a gas found in air.

Suggested activity: After discussing the first two paragraphs on this page, your pupils may wish to extend the previous activity of making a model plant cell into an activity in making models of cell division. Using three more of the same kind of plastic boxes, the pupils can adequately depict the process of cell division. To depict cell growth, they can cut one of the boxes in half and leave a space between its ends. With clear plastic they can cover the space between the ends after they have put in the parts of the cell done in modeling clay. The nucleus should be elongated in this model. The next models would show the two cells formed as a result of cell division.

Suggested research: After discussing the last paragraph on this page, the pupils may wish to know more about food making in green plants. Have them look in reference books under *photosynthesis*.

Plant cells can also store the food they make. For example, carrots store food in the cells of their roots. Other plants, like cabbages, store food in the cells of their leaves. The parts of these plants that have stored food are the parts people eat.

Exploring on Your Own

People eat food stored in plants every day. Visit the fruit and vegetable section of a grocery store. Try to figure out which plants store food in their roots; in their stems; in their leaves; in their flowers. You may want to ask someone who works in the store to help you.

Sample findings for "Exploring on Your Own": Sweet potato, beet, and parsnip plants store food in their roots. White potato, celery, and asparagus plants store food in their stems. Cabbage, lettuce, and spinach plants store food in their leaves. Cauliflower and broccoli plants store food in their flowers. Apple, orange, and pear trees store food in their fruits. Peanuts, peas, corn, and many kinds of beans store food in their seeds.
Suggested research: Many of the foods that are commonly grown today have an interesting history. Have your pupils find out where certain foods, such as potatoes, were first grown. Have them look in reference books under *food*.

New plants like the old ones. There are many kinds of seeds and spores. It's sometimes hard for you to tell what kind of plant will grow from a seed or a spore. But this is not a problem to the seed or the spore.

Information about the way a seed or a spore should grow is already stored in the nucleus of each cell of the seed or the spore. Because of this information the plant can grow to only a certain size. It will grow only a certain kind of leaf and stem. What other information might the nucleus of each plant cell have? [1]

Making seeds and spores sprout

You may have seen seeds for sale at a store. The seeds are in packages or boxes. They may stay in the store for months. But they do not sprout, or begin to grow. Then someone may buy the seeds and plant them. For the seeds to sprout, they must have certain things. Spores must have these same things.

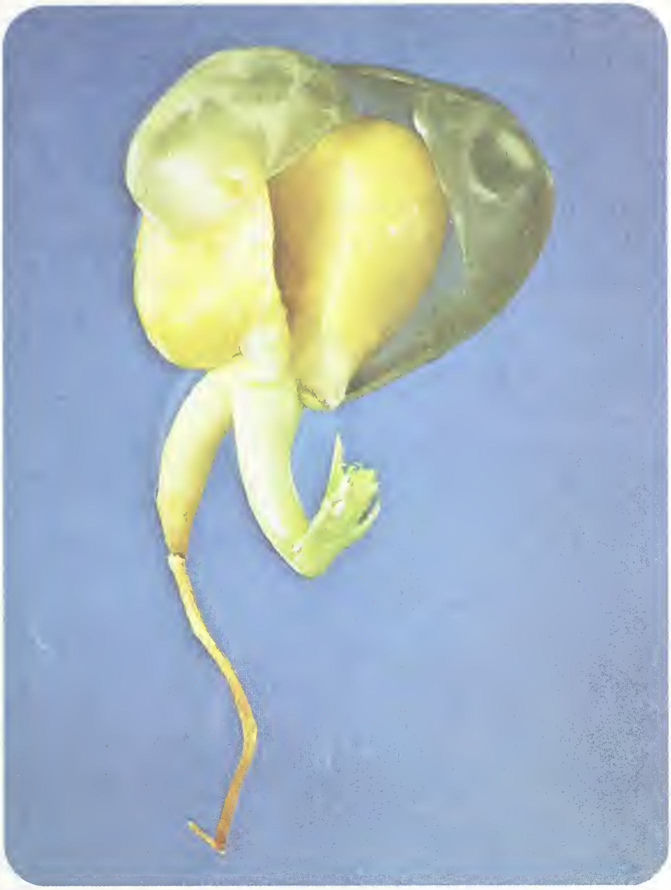
Water. When seeds and spores are put in wet ground, things begin to happen to them. In the case of seeds, they swell with water. The seed coats then open. The tiny plants can then start to grow.

Water also helps spores sprout. Which do you think need more water to sprout, spores or seeds? Why? [2]

[1] **Sample answer:** Information about the kind of flower the plant will grow.

[2] **Sample answer:** Seeds, because they are bigger and the water has to penetrate the seed coat.

Suggested discussion: After discussing "New plants like the old ones," your pupils may be curious to know how a nucleus can store information about how a seed or a spore should grow. An introduction to DNA is probably beyond the scope of this level, but you might point out that certain chemicals in living things can cause the living things to grow in a special way. Each kind of plant has its own special chemicals in the nucleus of each of its cells.



After a seed has sprouted, what things does it need to keep growing?

Air. Seeds and spores need more than just water to sprout. They also need oxygen, just as you do. Seeds and spores get oxygen from the air in soil. Seeds and spores need oxygen so they can use the food stored in them. The oxygen helps free the energy from the food. Why do seeds and spores need energy?[1]

[1] **Sample answer:** They need energy to sprout and grow.

Teaching helps for the picture above: You may wish to have the pupils identify the parts of the sprouting seed: seed coat, seed leaf, new plant, new root, new shoot. They may notice that the new shoot is starting to bend upward so that it can grow toward the light. The new root is growing downward. Ask the pupils why they think the seed coat is falling off. (Sample answer: Moisture made it crack open, and the growing plant is now too big for the seed coat.)

Sample answer for the caption: Water, air, warmth, light, minerals.

Warmth. Suppose you wanted to plant some seeds outside. If you wanted to grow pumpkin seeds, you would have to plant them in the spring. There is enough warmth at this time of the year for the pumpkin seeds to sprout. Every seed or spore needs a certain amount of warmth to sprout. At what time of the year have you planted seeds outdoors? What kind of seed did you plant?

Suggested activity: After discussing "Making seeds and spores sprout" on pages 18–20, your pupils may wish to devise their own experiment to show that seeds and spores need water, air, and warmth to sprout.

Teaching helps for the pictures above: Have the pupils note the seasonal changes in the two pictures. Ask them what conditions were present in the first frame to make it favorable for the planting of pumpkin seeds. Pupils may wish to know when to plant seeds for their favourite plants. To find this out, they may wish to visit a store where seeds are sold. They may look on the seed packages or ask someone in the store to help them find this information.

FINDING OUT

How can you grow plants from parts other than seeds or spores?

You will need: 2 coleus or geranium plants in pots

Although most plants grow from seeds or spores, some plants can begin to grow from other parts as well.

- Cut off the stem of one of the plants, just below the bottom leaves.
- Place the cut end of the stem about 8 cm into the soil of the pot with the other plant. Place the cut end as far away from the other plant as you can.
- Be sure to keep the soil moist.
- Watch the 2 plants for about 4 weeks.

Did your plant grow from just a stem?

- Find out what other plants can grow from parts other than seeds or spores.

Try growing them.

A Second Look

1. What are the parts of a seed?
2. What part of a plant cell helps make sure the new plant will grow as it should?
3. What things do seeds and spores need to sprout?

Teaching helps for "Finding Out":
Processes used: observing, experimenting.
Sample findings: The pupils will most likely find that both geranium and coleus plants will grow from cuttings. Potato plants grow from pieces of potato (underground stem) which have "eyes," or buds. Many flowering plants such as gladioli, lilies, and tulips grow from bulbs, which are specialized stems.
Additional information: In order for geranium or coleus plants to grow from cuttings, leaves must be present on the stem. This is because the leaves produce a growth chemical necessary to initiate root growth.

Sample answers for "A Second Look": 1. The parts of a seed are the seed coat, the seed leaves, and the new plant which has the new root and new shoot. 2. The nucleus of a plant cell makes sure the new plant grows as it should. 3. Seeds and spores need water, air, and warmth to sprout.

2 Plant behaviour and nonliving things

It's fun to watch plants grow from day to day. As plants grow, they do many things. Some parts of plants grow up. Some parts grow down. The things a plant does are called its *behaviour* [bih-HAY-vyur]. Do you think plant behaviour is different from animal behaviour? If so, in what ways? 1

[1] **Sample answers:** Yes. Because plants are not able to move around as animals do.

Main concepts of the chapter (pages 22–29):
Roots grow down because of the earth's pull and because of growth chemicals in the roots.
Stems have chemicals in them which cause them to grow upward against the pull of the earth.
The leaves of many plants turn toward light because of growth chemicals in the stem.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

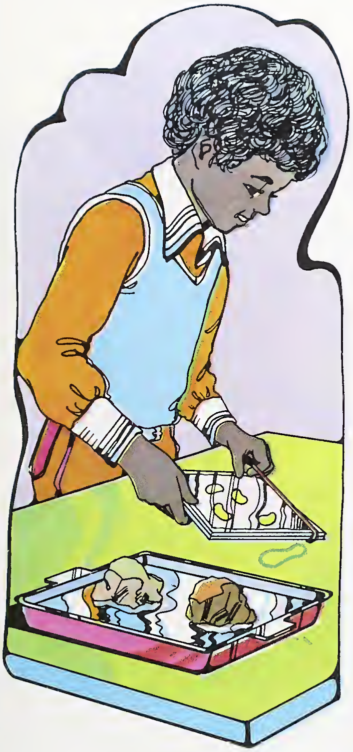
- —list two things which cause roots to grow downward;
- —state what causes stems to grow upward;
- —state what causes plants to turn toward light;
- —state what causes the roots of a plant to grow toward water;
- —describe what happens to the leaves when the air is very dry.

Important words: behaviour, chemicals.

Up or down?

When a seed starts to grow, a tiny root comes out first. And somehow it always grows in the right direction. It seems to know where "down" is. Why do you think this is important? [1]

[1] **Sample answer:** Because plants need the water and minerals that are in the ground.



FINDING OUT

Can you make the parts of a seed grow in the wrong direction?

You will need: about 4 bean seeds; paper towels; 2 small, flat pieces of glass; tray of water; 2 small rocks

- Soak the seeds in water for a day.
- Lay 1 piece of glass on a table. Place a moist paper towel on the glass.
- Put the seeds on the paper each facing in a different way (up, down, sideways).
- Put the other glass on top. Wrap rubber bands around the 2 pieces of glass as pictured.
- Set the pieces of glass upright in the water so the paper towel stays moist. Use the rocks to support the pieces of glass. Wait until the seeds sprout.

Did all the roots grow in the same direction? Why or why not?
Did all the stems grow in the same direction? Why or why not?

- Save these plants for the next Finding Out.

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring. *Sample findings:* The pupils will most likely find that the roots of the seeds that were turned upside down and sideways turn around to grow downward. The stems of the seeds that were turned upside down and sideways turn around to grow upward. The pupils may feel that this happens because roots always grow downward and stems always grow upward. Others may say that the root needs what is in the soil (water and minerals) and stems need what is above the ground (sunshine and air). These answers will serve as a springboard for a discussion of the text on succeeding pages.

What makes a root grow down? Suppose you lie down on your side. Even if you were blindfolded, you would still know which way is down. Your brain and a special part inside your ear help you to know this.

If a plant were to be placed on its side, it would have no brain or ears to help it. But it would still know which way is down. It knows this because of the pull of the earth on certain *chemicals* [KEHM-ih-kuhlz] in the root. These chemicals help the root grow down.

Besides reaching for water, why is it important that the roots of a plant grow down?

Sample answer for the caption: The ground has many minerals the plant needs, and the plant gets well anchored when its roots are in the ground.

What makes a stem grow up? Have you ever played tug-of-war? If you have, you know that two teams pull against each other with a rope. The stronger team wins. It pulls the losing team over a line. Plant stems play tug-of-war with the earth.

You know that the earth pulls roots toward it. It also pulls stems toward it. But stems grow up, not down. Growth chemicals in the stems help the stems pull harder. The stems win the tug-of-war over the earth's pull.

Why is it important for the stem of this corn plant to grow upward?

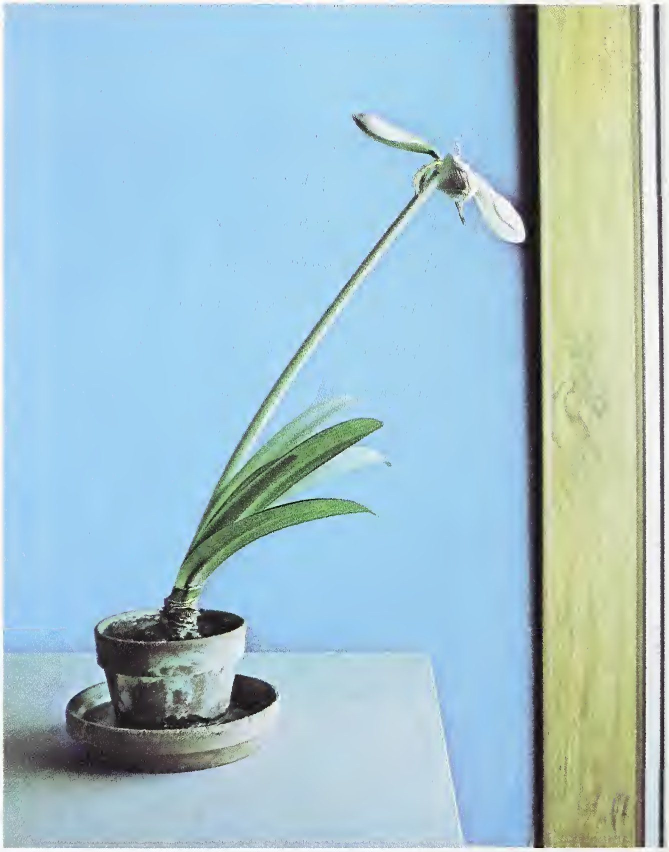
Sample answer for the caption: The plant makes food in its stem and leaves. In order to do this, it needs sunlight. It also needs carbon dioxide and water to make its own food.

Exploring on Your Own

Besides light, another nonliving thing that is thought to make plants behave in certain ways is sound. For example, many experiments have been done to see how plants behave because of music. Try to find out the results of these experiments. Look in a reference book under the heading *plants and sound*.

Facing the light

You probably know that green plants need light to grow. Some plants can grow so they get the amount of light they need. Suppose a plant were getting light from only one side. The stem might then grow so that its leaves would be turned toward the light. The stem of many green plants can do this because of growth chemicals in the stem.



Sample findings for "Exploring on Your Own": From some experiments, it seems plants grow best when soft, beautiful music is played all day long around them. Loud rock music seems to keep plants from growing well. These results, however, are not conclusive.

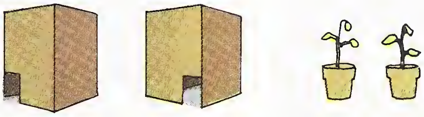
FINDING OUT

How can you show that plants grow toward light?

You will need: 2 small plants such as the bean plants from the Finding Out on page 23, 2 cardboard boxes

- Cut off the top of each box.
- Cut out a hole in the lower corner of one of the sides of each box.
- Place the plants on a windowsill.
- Cover each plant with a box. Make sure the hole in one of the boxes is facing left. The hole in the other box should be facing right.
- When you water the plants, make sure you give each plant the same amount of water. Wait about a week.

Did both plants grow toward the light? If so, try switching the plants in each box to see if they will again grow toward the light.



Thirsty plants

After you have been playing in the sun, you often become thirsty. You want to drink something. Your body needs water. Plants also need water. In what ways do you think plants use water?[1]

[1] **Sample answer:** In growing and in making food.

Teaching helps for "Finding Out":

Processes used: observing, comparing.

Sample findings: The pupils will most likely find that the stem and leaves of the plant will bend toward the light. When they switch the boxes, the plants will make a further adjustment in order to receive the maximum amount of light.

Extending the "Finding Out": Your pupils may wish to devise boxes that have the light coming through other parts of the box. They may try putting a hole in the top of a box. Three partial shelves can be staggered in the box so that the first shelf is attached to the right side of the box, the second is attached to the left side of the box, and the third is attached to the right side of the box. Since the light from the top reaches the plant below, the plant grows first to the left, then to the right, and finally to the left, until it reaches the maximum light at the top.

Rooting for the plant. Most plants get water from the soil. The roots help the plant get the water it needs. But suppose the soil right around a plant is very dry. If there is water somewhere nearby, a little bit of the water may reach the root. That will cause the root to grow toward the place where more water can be found.

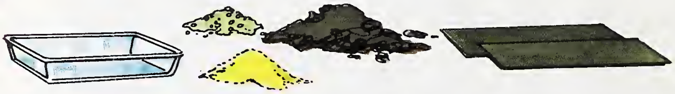
FINDING OUT

How can you show that roots grow toward water?

You will need: long, glass baking-dish; soil; sand; gravel; 2 seeds (such as bean seeds); dark paper

- Put a layer of gravel and sand in the bottom of the glass dish. Fill the dish with soil.
- Plant each seed next to a side of the dish, halfway from either end as shown. Be sure you can see the seeds through the glass. Water the seeds.
- After the seeds sprout, keep the soil at only one end of the pan moist.
- Keep the sides of the glass dish covered with black paper unless you are checking the seeds.
- Check them once a day for about 2 weeks.

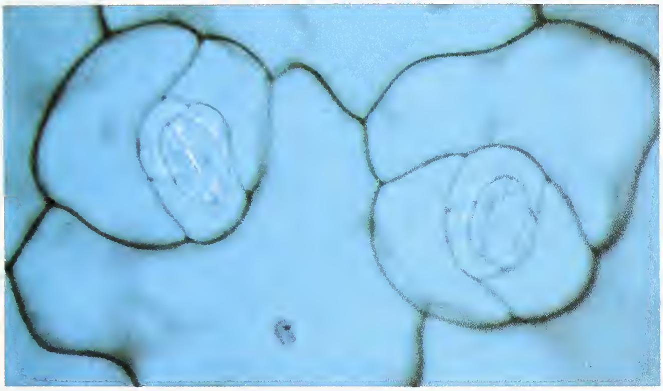
In which direction do the roots grow? Why?



Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: The pupils may find that the roots have grown toward the side which was watered. When a little water reaches the root from that side, the root is stimulated to grow toward the water.
Extending the "Finding Out": To show how other plant parts respond to water, you might have the pupils put a dandelion that has gone to seed in each of two glasses of water. Cover one glass with a glass that just fits over the first glass. Put both dandelion stalks in the sunlight. After a day, the air around the covered seeds will get very moist. Ask the pupils how this might protect the seeds. (Sample answer: This will cause the hairs to stay close together, preventing the seeds from being dispersed. When the air is dry, the dry seeds are carried far away by the wind.)

Leaves and water. At some time you have probably breathed on a window and made it cloudy. The window clouded up because of water vapour that you breathed out. Plants also "breathe" out water vapour. Plants have openings on their leaves for doing this. But when the air is very dry, the plants give off very little water vapour. The dry air causes the openings on the leaves to close up. What might happen to a plant if it lost too much water through its leaves? [1]

[1] **Sample answer:** It would shrivel up and die in a short time.



This picture of leaf cells, which has been greatly magnified, shows two of the special cells which give off water vapour. One of them is just beginning to open. What might be causing this?

A Second Look

1. What makes roots grow down?
2. What might some plants do to get the amount of light they need?
3. In what ways might water make a plant behave?
4. What other nonliving things make plants behave as they do?

Sample answers for "A Second Look": 1. The pull of the earth and growth chemicals in the roots make the roots grow down. 2. The stems of some plants may grow in such a way that the leaves are then facing the sun. 3. Water might make the roots grow in the direction of the water in the soil, and it may also make the special cells in the leaves open. 4. Warmth and air are other nonliving things that make plants behave as they do. **Sample answers for the caption:** The plant may have just been watered. The plant may just be starting to make food for the day.

3 Plant behaviour and living things

As you may know, many nonliving things around a plant may make it behave as it does. Water is one of these things. Light is another. But living things around a plant also affect the way a plant behaves.

Some plants twine and climb on other plants. How might this help the twining plant?

Main concepts of the chapter (pages 30–43):
Many plants have ways of protecting themselves from other living things.
Plants have many ways of helping other living things.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—explain three ways that plants defend themselves from other living things;
—state two ways that animals help plants;
—describe two ways that plants help animals;
—state three ways in which plants help other plants.

Important words: creosote, poison ivy, mimosa, sundew, Venus's-flytrap, cactus, mistletoe, kapok, yucca, marigolds.

Sample answer for the caption: It might help the twining plant get enough light.

Plant defenses

Have you ever been in a crowded store? If so, you know how it feels to be crowded. People push and squeeze you. You want to get away from the crowd!

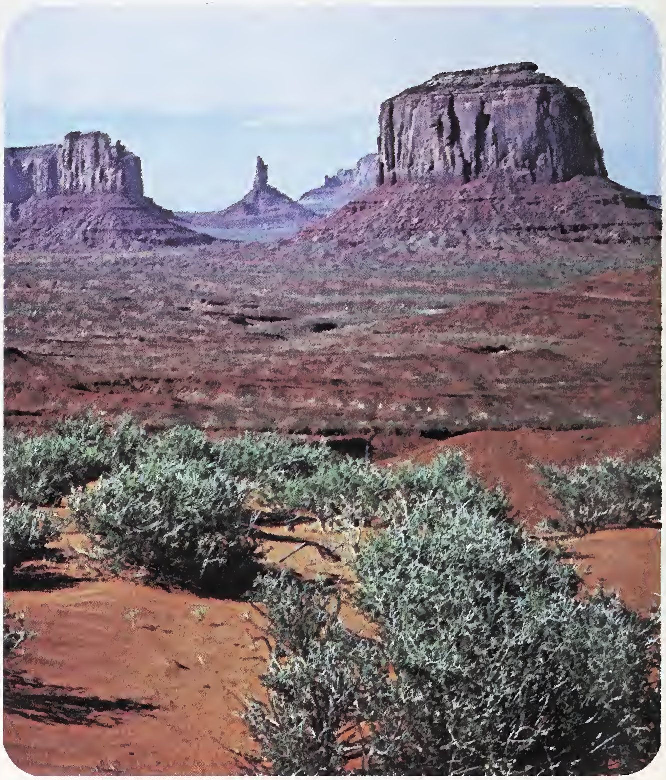
Being crowded can be a problem for plants, too. Crowded plants may not be able to get what they need to grow well. But they can't just walk away from other plants. However, plants do have ways of taking care of this and other problems. Why do you think this is important?[1]

[1] **Sample answer:** It helps the plants survive under difficult conditions.

Many kinds of seeds and spores fall to a forest floor. Why won't all the seeds and spores get to be full-grown?

Sample answers for the caption: There isn't enough room for them all. Some of the plants wouldn't get enough light.

Making poison. You most likely know that deserts get very little rain. Some desert plants have many roots. These roots help them get as much water as possible. But if other plants get too close, there may not be enough water for all of them. One desert plant, the *creosote* [KREE-uh-SOHT] bush, takes care of this. The roots of this bush give off a poison. Suppose another plant, even a young creosote bush, started to grow near an older creosote bush. The poison from the older plant would kill off the younger plant. This takes care of the problem of crowding for the creosote bush!



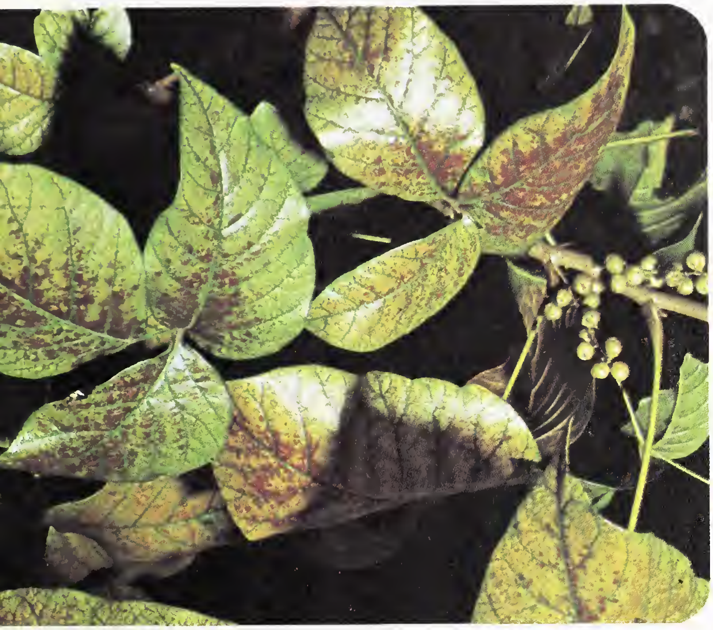
Besides the poison from the roots of these creosote bushes, what might keep them from crowding together?

Sample answer for the caption: The animals of the area might eat the seeds and keep the number of creosote bushes down.

Teaching helps for the picture above: Besides the creosote bush, some plants also make substances which are poisonous to other plants. A rubber plant from Mexico, the guayule, excretes a poison from its roots. The black walnut tree also spreads a poison through the soil around its roots. Furthermore, some plants don't actually poison other plants but they harm them by robbing them of water and minerals from the soil.

Some plants use poisons to protect themselves from hungry animals. Poison ivy makes a poison that bothers animals if they rub against it. Animals soon learn to stay away from poison ivy. What other plants do you know of that make poison?[1]

[1] **Sample answer:** Poison oak, poison sumac.



The leaves of poison ivy usually grow in clusters of three. Its small berries are also helpful to people in recognizing poison ivy. Why is it important for people to recognize poison ivy?

Drooping plants. Some plants have a different way of protecting themselves. A certain grass is found where animals graze. If animals get near this grass, the grass droops. Then the grass doesn't look good to eat. The animals may pass it up.

Sample answer for the caption: If people recognize poison ivy, they will stay away from it or will destroy it.

Another plant, the *mimosa* [muh-MOH-suh], also droops at times. As soon as someone touches it, it draws its leaves close together. This can be thought of as the mimosa's way of saying, "Hands off!"

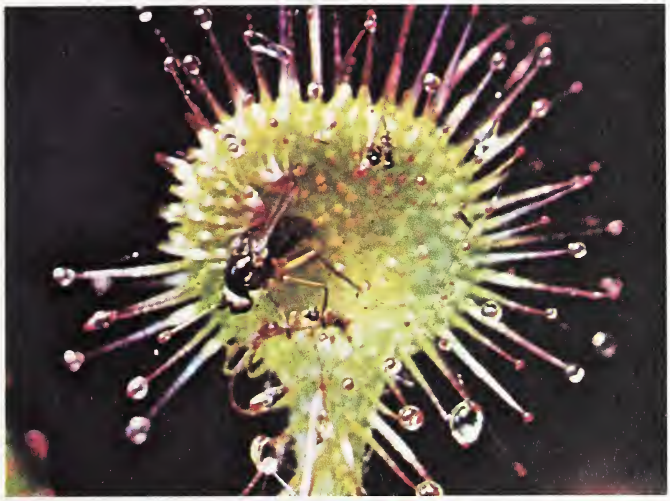
When the leaves of the mimosa are touched, the water in special cells moves to other cells. How might this cause the leaves to droop?

Eating animals. You know that animals often eat plants. But did you know that some plants eat animals such as ants and flies?

These plants can grow in very poor soil. The soil does not have to supply all the minerals these plants need. These plants get some of the minerals they need from the animals they eat.

Sample answer for the caption: When the water moves away from the special cells, that part of the leaf loses its stiffness. When that happens the leaf droops.

One plant, the sundew, has sticky hairs all over its leaves. When a fly lands on a leaf, the fly gets stuck. Nearby hairs bend toward the fly. More sticky stuff pours over the fly. The fly cannot get away. Juices from the plant turn the fly's body into a "soup." The plant takes in this "soup" through its leaves.



Besides flies, what other animals do you think might get caught by the sundew plant?

Teaching helps for the pictures above: The sticky hairs of the sundew plant do not all respond at once to the presence of the insect on its leaf. First, the hairs close by bend over the insect. After fifteen or twenty minutes, more hairs bend. It may take several hours before all the sticky hairs wrap the insect inside. They remain closed until the entire insect is digested, which may take more than a week.

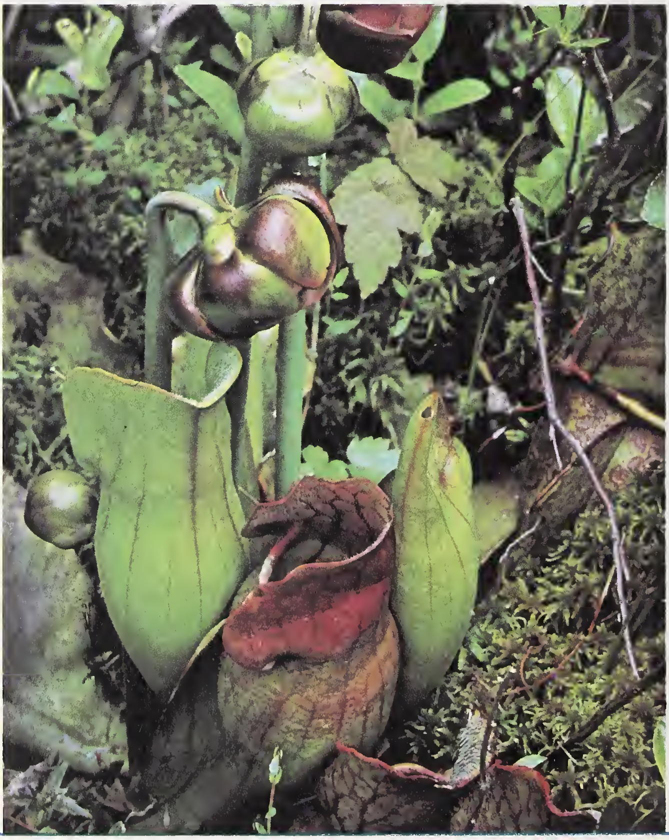
Sample answers for the caption: Ants, bees, beetles.

Another kind of animal-eating plant is the pitcher plant. Certain leaves of the pitcher plant catch rainwater. Ants or other small animals may crawl into these leaves looking for nectar. They often slip and fall into the water. That's the end of the ants! Juices from the plant soon digest them. What other animals might drown in a pitcher plant?[1]

Another plant also eats animals. It is called the Venus's-flytrap. When a fly lands on a leaf of this plant, the leaf closes up quickly. The fly cannot escape. Soon it is digested. What if a tiny ant crawled into the trap. How might it escape?[2]

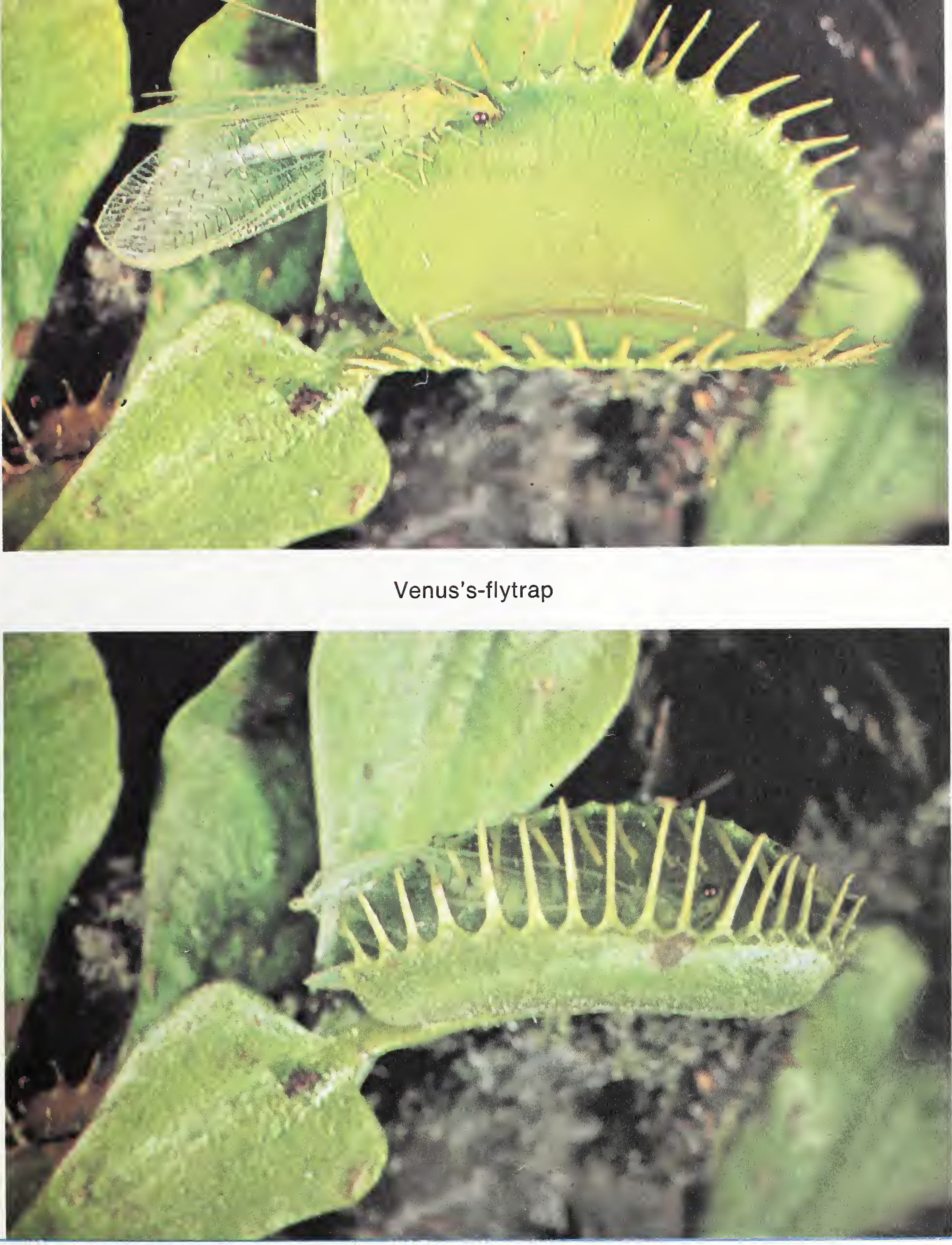
[1] **Sample answer:** Beetles, cockroaches.

[2] **Sample answer:** It might crawl out between the teeth of the trap.



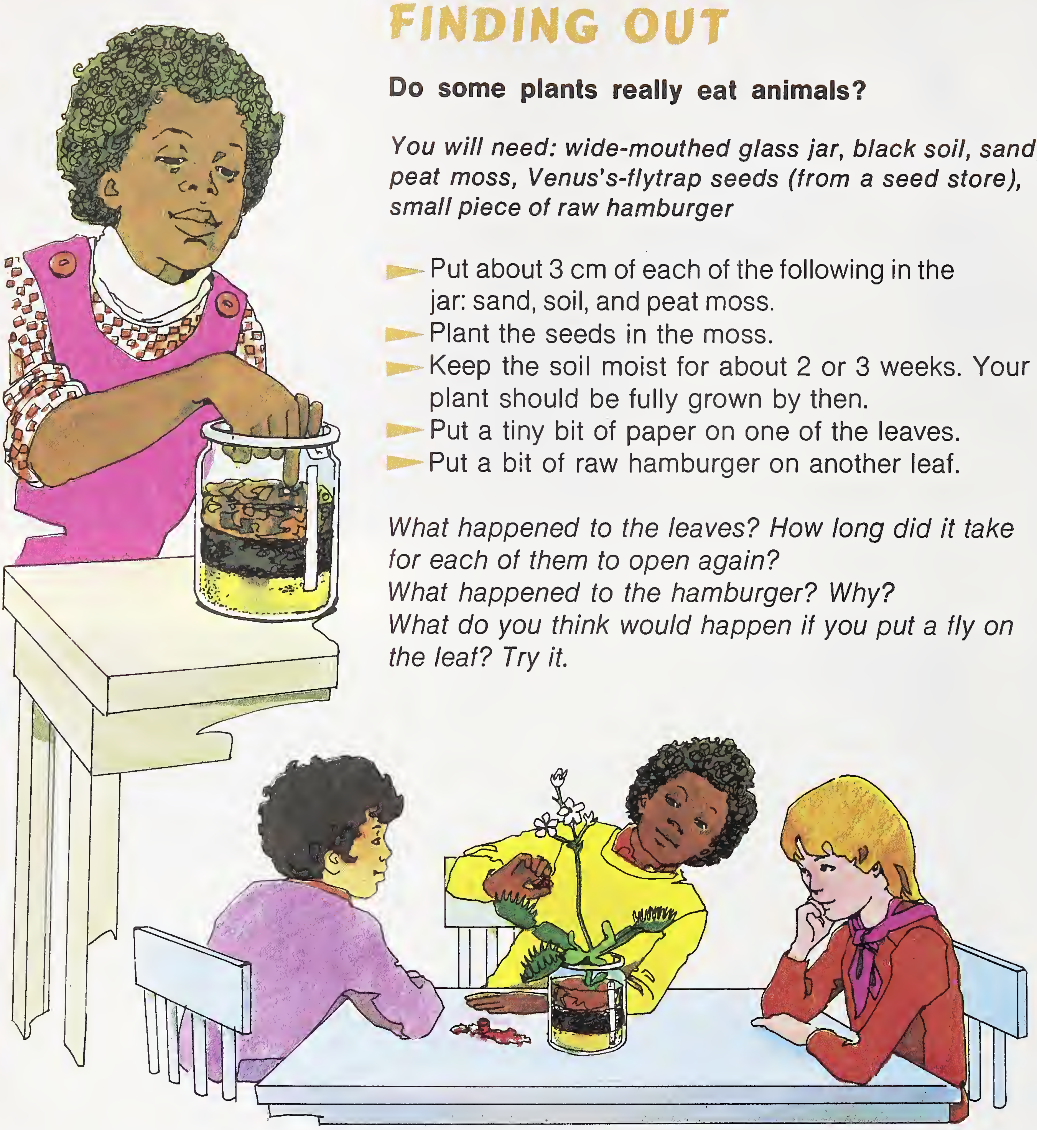
Pitcher Plant

Teaching helps for the picture above: Insects are lured to some pitcher plants by their distinctive odour. Near the rim of the pitcher they find sweet-tasting nectar. As they try to reach the nectar, they often fall into the pitcher, where digestive juices are ready to do their work on the victim. If the insects try to crawl out, a slippery region and a place where hairs bend downward make this extremely difficult.



Venus's-flytrap

Teaching helps for the pictures above: The Venus's-flytrap has three sensitive hairs on each half of its leaf which help it to feel the presence of an insect on the leaf. The leaf will not close unless two hairs are touched in succession or the same hair is touched twice. After it closes, the leaf squeezes the insect, so that the insect rubs the digestive glands on the leaf. This causes the release of digestive juices over the insect's body.



FINDING OUT

Do some plants really eat animals?

You will need: wide-mouthed glass jar, black soil, sand, peat moss, Venus's-flytrap seeds (from a seed store), small piece of raw hamburger

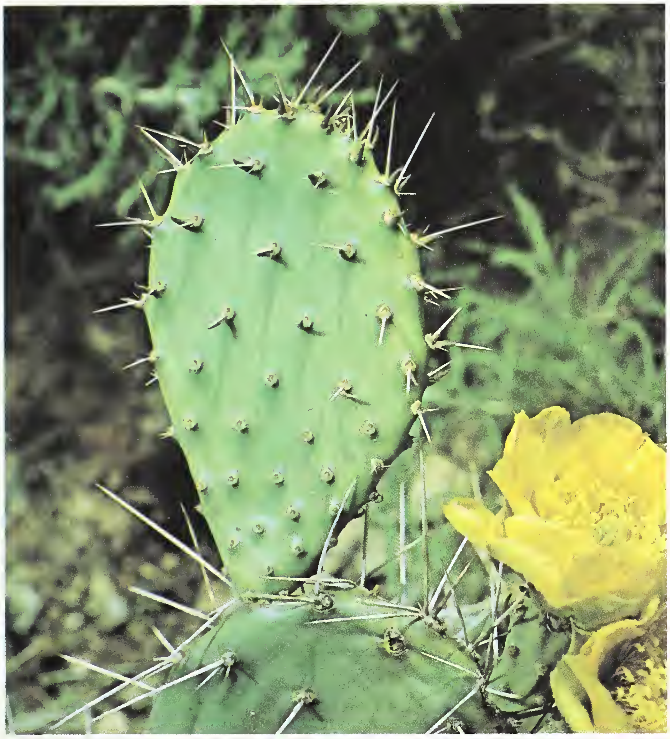
- Put about 3 cm of each of the following in the jar: sand, soil, and peat moss.
- Plant the seeds in the moss.
- Keep the soil moist for about 2 or 3 weeks. Your plant should be fully grown by then.
- Put a tiny bit of paper on one of the leaves.
- Put a bit of raw hamburger on another leaf.

What happened to the leaves? How long did it take for each of them to open again?
What happened to the hamburger? Why?
What do you think would happen if you put a fly on the leaf? Try it.

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring, predicting.
Sample findings: The pupils will most likely find that the leaves of the Venus's-flytrap will close around the paper and the hamburger. But the leaf which closed around the paper will open again the next day. The leaf which closed around the hamburger will not open again for over a week. By that time, the hamburger will have been digested by the leaf. A fly put on the leaf will probably get caught inside the leaf. The leaf will digest the fly after a week.

Having weapons. Some plants take care of themselves in still another way. They have weapons. For example, the cactus has spines all over its stems. How might these spines protect the cactus?[1]

[1] **Sample answer:** The spines would keep animals from eating cactus plants.



Spines help the kapok tree, too. Sometimes birds have mistletoe seeds stuck to their feathers. They rub the seeds onto some plants. The mistletoe then starts to grow on these plants. But the mistletoe

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Teaching helps for the picture above: The spines on the cactus serve a twofold purpose. The spines keep animals from eating the stems and also help the plant retain water. The spines are the leaves of the cactus. Spines are not conducive to the loss of water, as are broader leaves.

can be harmful to these plants. It steals the water these plants take in from the soil. But, because of the kapok's spines, birds don't rub mistletoe seeds off on the kapok tree. This protects the kapok tree from mistletoe.

SPINY KAPOK TREE

The kind of kapok tree that has spines lives mostly in the tropics. What other plants do you know of that have spines?

Plant "friendships"

You probably have a good friend to play with. A friend is someone you can depend on. A friend is often helpful to you.

Sample answer for the caption: Cactus plants, some weeds.

Teaching helps for the picture above: All kapok trees do not have spines. Kapok trees with smooth branches are often bothered by mistletoe.

Some plants have a kind of "friendship" with certain animals. They are not really "friends," of course. But they do seem to help each other out. Other plants have a "friendship" with certain plants.

Animal "friends." At certain times some plants have flowers on them. Some flowers have bright colours. The colours attract insects like bees. The flowers also make sweet nectar that many insects like to drink. In return, you might say the insects do a favour for the flowers. The insects carry pollen from a flower to another flower of the same kind. Pollen is the white or yellow dust made by certain parts of flowers. Pollen is needed by the flowers to make their seeds. What flowers do you know of that attract insects? [1]

[1] **Sample answer:** Peach blossoms, apple blossoms.

Suggested discussion: After discussing "Animal 'friends'" on this page and the next, your pupils may be interested in other plant-animal relationships. They may have seen plants with special hollow parts, like hollow spines, or recesses at the base of leaves, where ant colonies reside. You might ask how these plants and animals help each other. (Sample answer: Nutrients important to the ants are available in these plants. The plants are helped by the droppings from the ants, which provide minerals needed by the plants.)

One plant, the *yucca* [YUHK-uh] plant, has a special friend. It is the yucca moth. The yucca flower opens up just once. It opens one evening. It stays open all that night. The next morning it closes, never to open again. Because it stays open only at night, day insects, like bees and butterflies, cannot carry its pollen. But the yucca moth flies at night.

At night the yucca flower, which is white, shines in the moonlight. It also gives off a sweet smell. These things attract the yucca moth. The yucca moth then carries pollen from one yucca flower to another. At the same time, the yucca moth lays its eggs in the yucca flower. How do you think this is helpful to the eggs of the yucca moth? 1

[1] **Sample answer:** The eggs of the yucca moth are well protected in the closed flower.

Plant "friends." Very often insects eat plants. People often spray the plants with insecticides. Insecticides kill the insects. But they often kill other living things, like birds and mammals. Sometimes the insecticides stay on the plants. They can get into the vegetables you eat. Why might this be harmful? 2

[2] **Sample answer:** People might be gradually poisoned by the insecticides.

There is a better way to keep insects and worms away from some plants. Certain plants can be used to chase away insects and worms from other plants.

Marigold plants make a poison. Because of this poison, insects and worms leave marigolds alone. This poison is also helpful to rosebushes growing near marigolds. The roots of rosebushes are often destroyed by roundworms. But the poison from the marigolds chases the roundworms away. Rosebushes which grow near marigolds are healthy.

Suggested research: After discussing "Plant 'friends,'" your pupils may wish to find out which insecticides are particularly harmful to people and what is being done in their own province to prohibit the use of these insecticides. They may also wish to learn more about natural control of insects by organic gardening. They may wish to contact the Office of the Environmental Protection Agency in their state to find out about these things.

Why do you think these marigolds have been planted near the cabbage? Where have you seen marigolds?

Rosebushes also grow better when garlic plants are near. The garlic keeps beetles away from the roses. Asparagus plants keep worms away from tomatoes. Onion plants keep carrot flies away from carrots.

What plants do you know of that are helpful to certain other plants?[1]

[1] **Sample answer:** I have heard that nasturtiums are helpful in keeping insects away from other plants.

A Second Look

1. Why do some plants eat animals?
2. What is one kind of weapon some plants have to protect themselves?
3. How do some plants and insects help each other?
4. How do some plants help other plants?

Sample answers for "A Second Look": 1. Some plants eat animals because the soil in which they are growing is poor and lacking in minerals. The insects and other animals supply minerals to the plants. 2. Some plants have spines. 3. Some insects carry pollen from one flower to another. These plants supply nectar and sometimes homes for the insects. 4. Some plants help other plants by keeping harmful insects from them by means of the poison they make.

Sample answers for the caption: Because marigolds make a poison which chases insects and worms away.

Workers Who Use Science

Many people like to grow plants. Plants make people's houses beautiful, inside and out. Plants add beauty to other buildings too. One person who helps people grow plants for the outside of buildings is the *plant-nursery worker*. Plant-nursery workers grow small trees and shrubs. They raise these plants in a plant nursery. They keep them until they are big enough to grow without much special care. When people buy trees or shrubs, the plant-nursery workers dig them up. The workers may plant them on the buyer's land.

Plant-nursery workers must know what kind of soil is best for each kind of plant. Sometimes they add minerals to the soil to make the plants grow better. They must know how much light and water the plants need. Plant-nursery workers make sure that each plant has enough room to grow.

Plant-nursery workers have to know which diseases plants can get. They should also know how these diseases can be prevented or cured.

To find out more about plant-nursery workers, try to find answers to these and other questions you may have about plant-nursery workers:

What else must plant-nursery workers do to make plants grow well?[1]

What kinds of trees and shrubs do plant-nursery workers grow?[2]

You may wish to use reference books or write to the Canadian Horticultural Council, 1568 Carling Avenue, Ottawa, Ontario K1Z 7M3.

Besides growing trees and shrubs, some nursery workers grow other kinds of plants, too. What might some of these kinds of plants be?

Sample answers for "Workers Who Use Science":

[1] Plant-nursery workers must keep harmful insects away from the plants.

[2] Plant-nursery workers grow small evergreen trees like spruce and pines, and decorative shrubs like forsythia, bridal wreath, and lilac bushes.

Sample answers for the caption: Geranium and ivy plants.

Reviewing the Main Ideas

Most plants begin to grow from a spore or a seed.
Plants are made up of tiny units of living matter called cells.
Plants grow when their cells grow larger and when their cells divide into new cells.
Seeds and spores need water, air, and warmth to sprout.
Roots grow down because of the earth's pull and because of growth chemicals in the roots.
Stems have chemicals in them which cause them to grow upward against the pull of the earth.
The leaves of many plants turn toward light because of growth chemicals in the stem.
Many plants have ways of protecting themselves from other living things.
Plants have many ways of helping other living things.

Reading About Science

Goldstein, Philip. *Animals and Plants That Trap.* Don Mills, Ontario: Saunders of Toronto Limited, 1974.
Rahn, Joan Elma. *How Plants are Pollinated.* Toronto, Ontario: McClelland and Stewart Limited, 1975.
Rahn, Joan Elma. *How Plants Travel.* Toronto, Ontario: McClelland and Stewart Limited, 1973.
Waters, John F. *Carnivorous Plants.* Toronto, Ontario: Grolier Limited, 1974.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 46.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to the topic of plant behaviour. Such articles might be found in reference books under the headings *plant behaviour, seeds, spores,* and *organic gardening.*

Testing for Understanding

Ideas to Check

On your paper write *T* for each sentence below that is true. Write *F* for each one that is false.

T 1. Light sometimes makes plants behave as they do.
T 2. Most plants begin to grow from either a spore or a seed.
F 3. Plant cells can be seen without a microscope.
F 4. Carbon dioxide makes some plants green.
T 5. Water, air, and warmth help seeds and spores sprout.
T 6. Some plants get some of the minerals they need by eating animals.

Words to Use

Write on your paper the word or words that best fit in each blank below. Choose from these words: *carbon dioxide, spines, earth's pull, chlorophyll, light, nectar, insects, oxygen, nucleus, poison, seed coat, microscope.*

1. The ____ helps make roots grow down. earth's pull
2. Information about the way a seed or a spore should grow is stored in the ____ of each cell of the seed or spore. nucleus
3. Plants that have ____ can make their own food. chlorophyll
4. Seeds and spores get ____ from the air in the soil. oxygen
5. Some plants have ____ on their stems, which helps them protect themselves. spines
6. Some flowers make ____, which insects like. nectar
7. Some plants chase away harmful ____ from other plants. insects
8. Some plants make a ____, which keeps them from being eaten by animals. poison

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Plant Growth and Behaviour" are provided for you on page T16 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22 of the Teacher's Manual.

Having Fun with Science

Fun with Words

An elephant said to a plant,
"We're related! Our names end in 'ant'!

"What else do you see
That relates you to me?
Take care if you don't want to flunk."

"Well, down to your knees
And up to my leaves
We both have a kind of a trunk!"

Try to make up some other rhymes about plants.

What Am I?

1. Plants use me for making food. I'm a gas, but I can't be used in a car.
2. I drink whenever there's water. I look for it in the ground.

Talking to Plants

There are people who say that talking to plants helps them grow better. Try it. Get two plants that are alike. Make sure both plants get the same amount of light and water. Talk to one of the plants every day. Be sure the other plant is in another room. See if you can notice any difference in the growth of the two plants after two or three weeks.

How Plants Begin

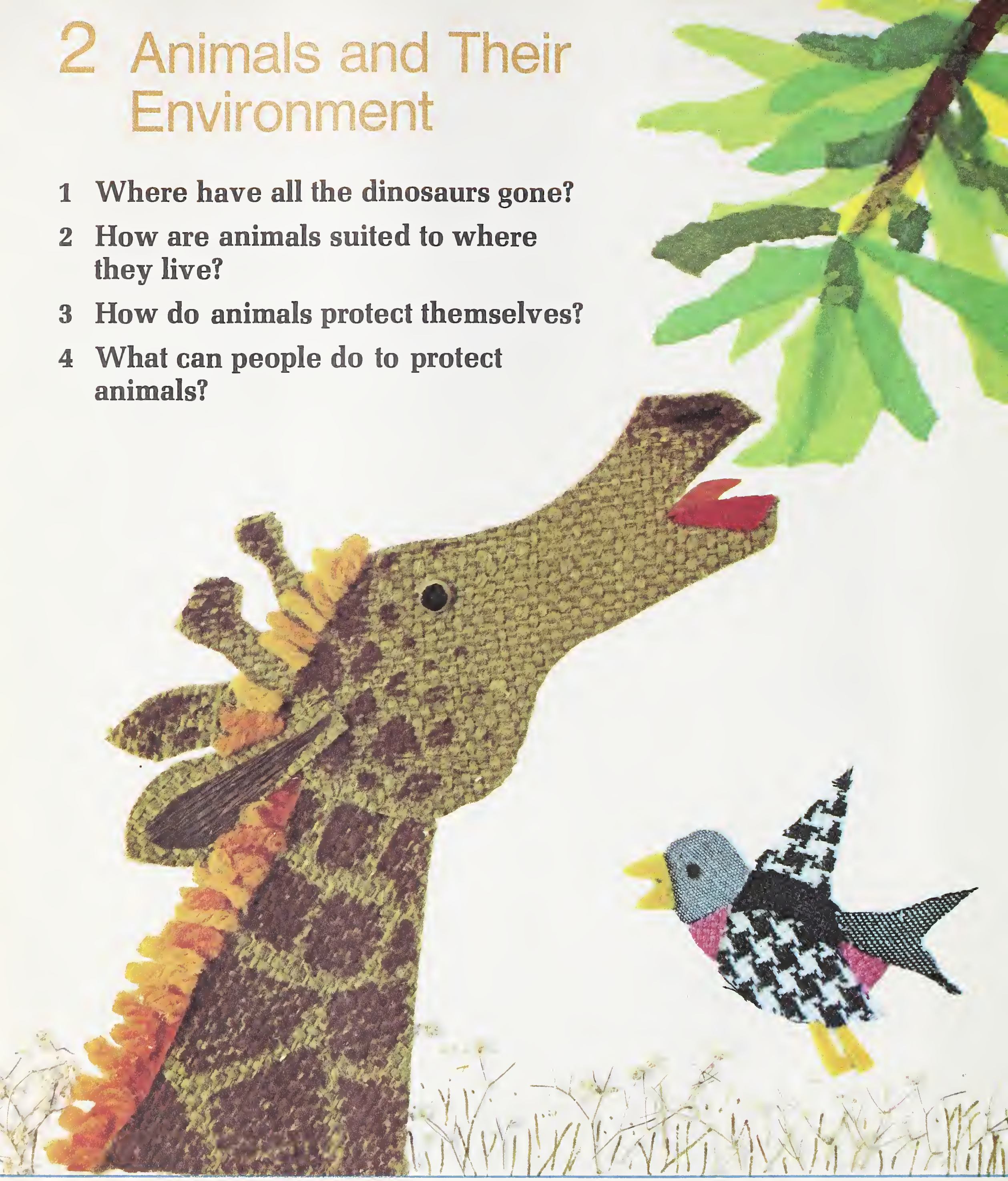
Visit a florist shop or a nursery. Try to find out which plants are grown from seeds or spores and which plants are grown from cuttings of older plants.

For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of the unit "Plant Growth and Behaviour." You may also wish to encourage the pupils to make up additional activities related to the topic of plant behaviour.

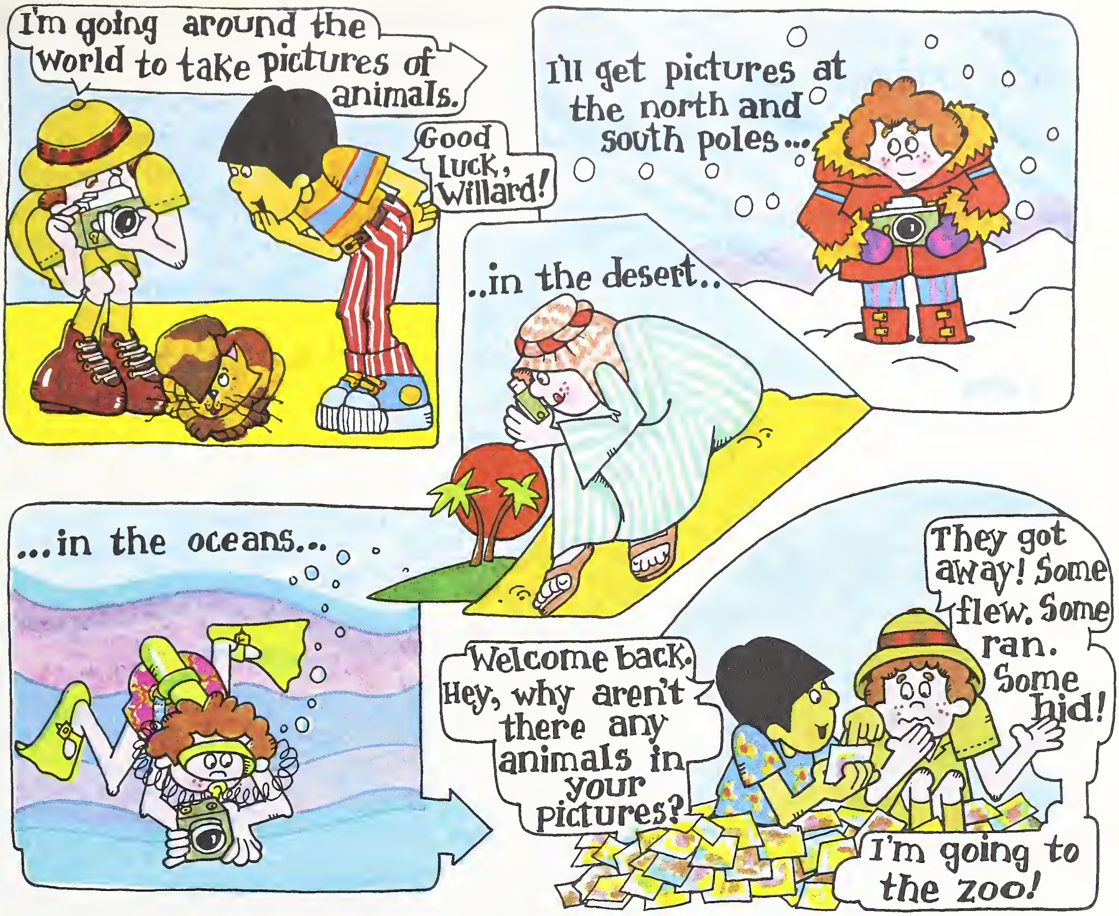
Answers for "What Am I?": 1. Carbon dioxide. 2. Roots.

2 Animals and Their Environment

1 Where have all the dinosaurs gone?
2 How are animals suited to where they live?
3 How do animals protect themselves?
4 What can people do to protect animals?



Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see page T13 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit and have the pupils begin collecting these materials. These activities are found on pages 57, 68, 71, and 81.


I'm going around the world to take pictures of animals.
Good Luck, Willard!
I'll get pictures at the north and south poles...
..in the desert..
...in the oceans...
Welcome back. Hey, why aren't there any animals in your pictures?
They got away! Some flew. Some ran. Some hid!
I'm going to the zoo!

What animals do you think Willard hoped to take pictures of?[1]

Why did he have to change clothes for each place he went?[2]

Why do you think the animals stayed away from Willard?[3]

Introducing the unit: You may wish to have the pupils read the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:

[1] Willard probably hoped to take pictures of animals like polar bears, seals, camels, and fish.

[2] He had to change clothes each place he went because some places were cold and some were hot. He also needed special clothes to swim.

[3] Most wild animals stay away from people and other kinds of animals because this is one way they can protect themselves.

1 Where have all the dinosaurs gone?

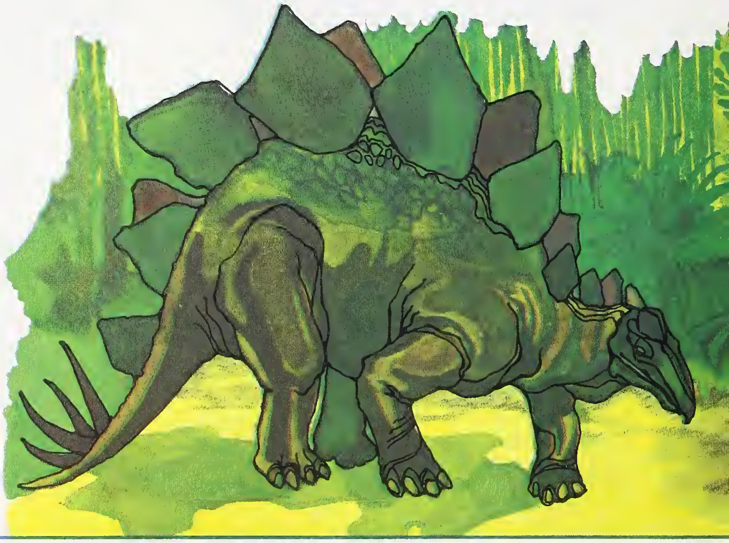
Have you ever seen drawings of animals that lived long ago? Or maybe the skeleton of such an animal? The picture below shows what some of these animals looked like. The animals in this picture are called *dinosaurs*. What are some things you know about dinosaurs?[1]

[1] **Sample answer:** Some were as big as buildings. They were green in colour.

Where did dinosaurs live?

What if you had lived at the time the dinosaurs lived. You probably would have seen some. Dinosaurs lived almost everywhere. In fact, many dinosaurs lived in North America!

Millions of years ago, most of the land on the earth was flat. This land was very swampy, or wet. There were also many plants growing on the land at this time. This was the kind of *environment* [ihn-VY-ruhn-muhnt], or surroundings, dinosaurs lived in.



Main concepts of the chapter (pages 50–57):
Dinosaurs were animals that lived long ago when most of the earth was flat and swampy.
It is thought that dinosaurs died out because their environment changed.
People learn about dinosaurs by studying their fossil bones and teeth.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—state two probable reasons why the dinosaurs died out;
—state two things that people can find out about dinosaurs by studying their fossil bones and teeth.

Important words: dinosaurs, environment, fossils.

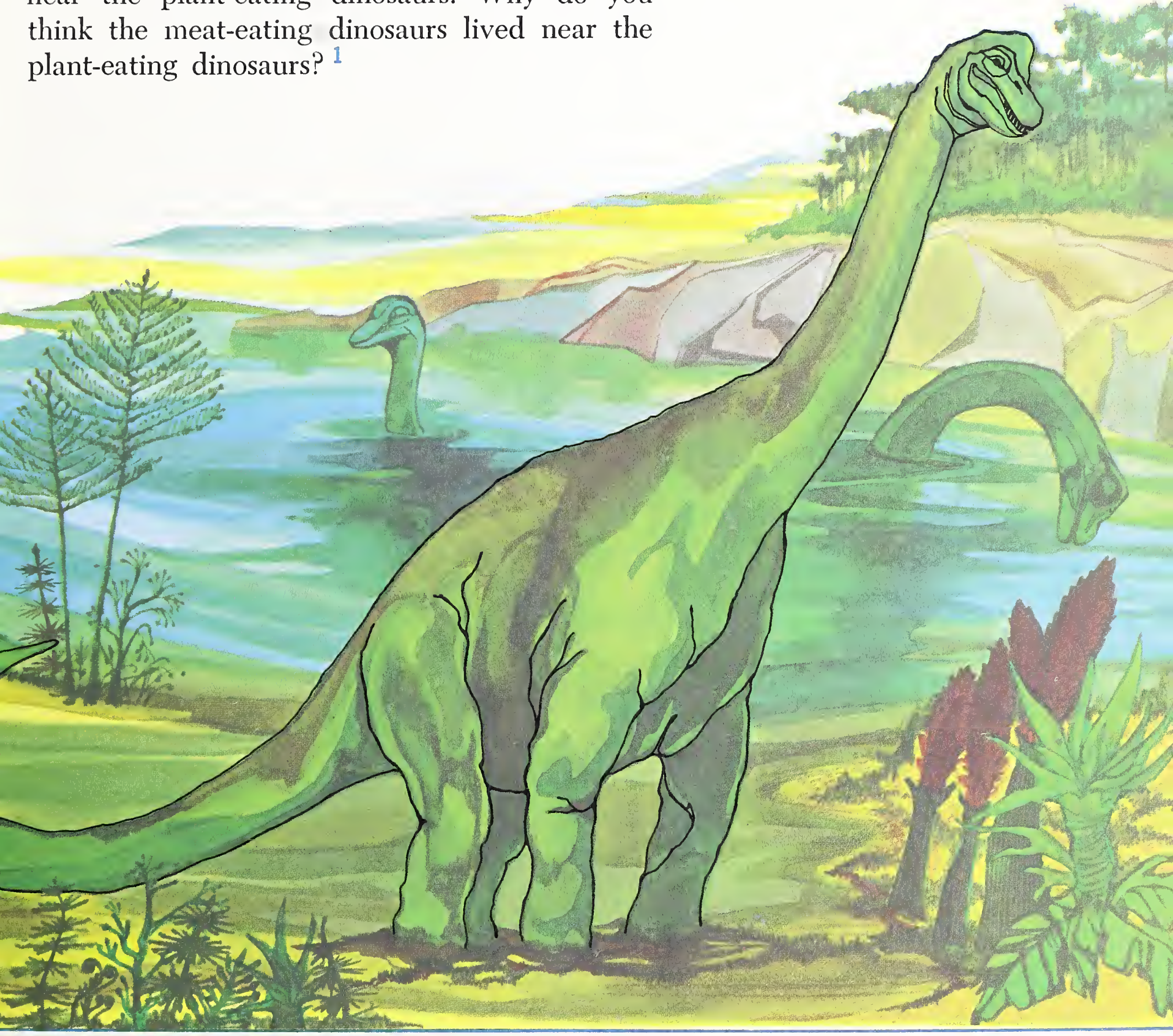
What kinds of food did dinosaurs eat?

Many dinosaurs were very big. So they had to eat large amounts of food to stay alive. But all the dinosaurs did not eat the same kinds of food.

Some dinosaurs were plant eaters. They ate the plants that grew on the swampy land.

Other dinosaurs were meat eaters. They lived near the plant-eating dinosaurs. Why do you think the meat-eating dinosaurs lived near the plant-eating dinosaurs?[1]

[1] **Sample answer:** So they would always have food.



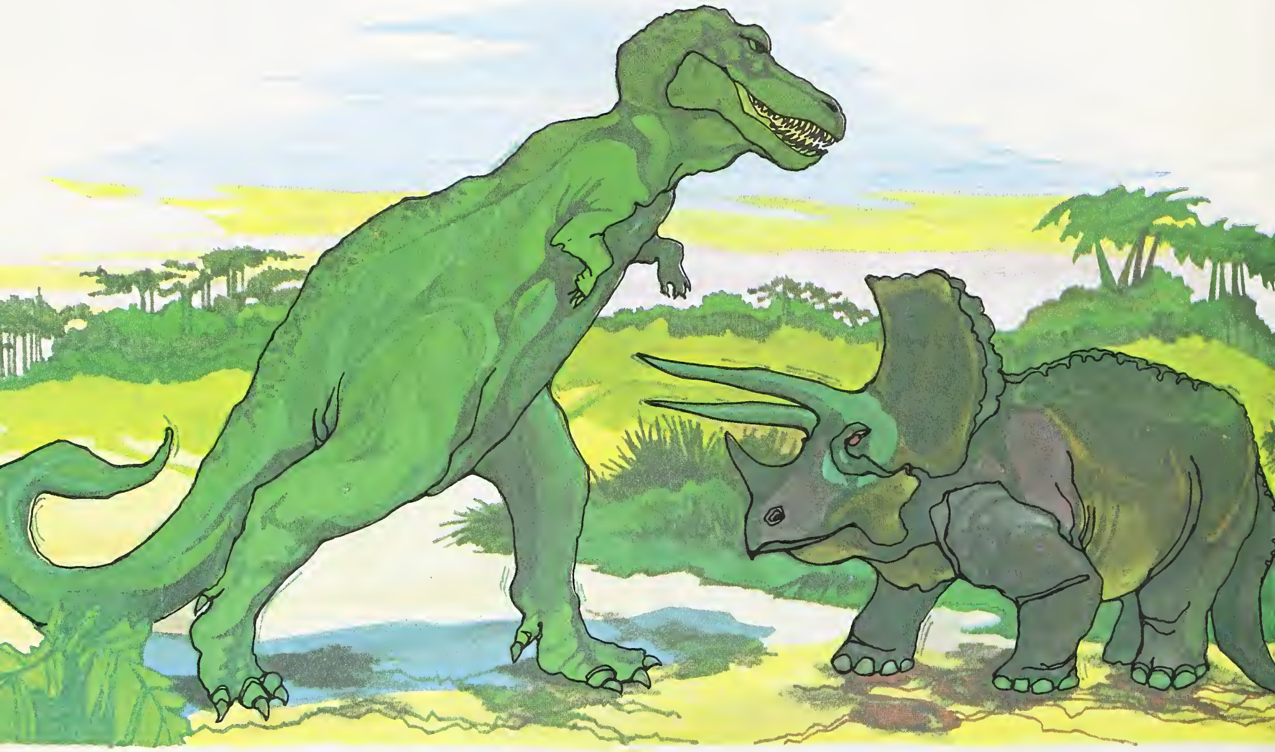
How did dinosaurs protect themselves?

Plant-eating dinosaurs often had to protect themselves from meat-eating dinosaurs. Some plant-eating dinosaurs were able to walk or swim into deep water. How might this have helped these plant-eating dinosaurs protect themselves? [1]

Some dinosaurs protected themselves in other ways. The picture on this page shows another way dinosaurs protected themselves. In what way are they protecting themselves? [2]

[1] **Sample answer:** Meat-eating dinosaurs probably could not swim.

[2] **Sample answer:** By fighting with their horns and teeth.



Suggested research and activity: After discussing "How did dinosaurs protect themselves?" the pupils might look in reference books to find out what some other kinds of dinosaurs looked like and how they protected themselves. You might then have the pupils find out which dinosaurs were plant eaters and which were meat eaters. Then have the pupils draw pictures of the different kinds of dinosaurs and make a bulletin-board display using their pictures to show which dinosaurs were plant eaters and which were meat eaters.

Why did all the dinosaurs die out?

As you may know, all the dinosaurs died out long ago. Many things happened which may have caused the dinosaurs to die out. What might some of these things have been? 1

The changing earth. As was said before, millions of years ago most of the land on the earth was flat and swampy. But as years passed, mountains formed. This caused much of the water to run off the land. Most of the swamps then dried up. When this happened, many of the plants the dinosaurs needed for food died. Why would this have been harmful to the plant-eating dinosaurs? 2 Why would this have been harmful to the meat-eating dinosaurs? 3

Other animals. There was another thing that happened which may have caused the dinosaurs to die out. At about the same time the land was changing, other animals moved into the dinosaurs' environment. Some of these animals probably ate dinosaur eggs and young dinosaurs. Others may have eaten the same kinds of plants some of the dinosaurs ate. How might these things have helped cause the dinosaurs to die out? 4

How do people know about dinosaurs?

Though the dinosaurs died out long ago, people are still learning many things about them. How do you think people know about dinosaurs? 5

[1] **Sample answer:** They may have run out of food. Other animals may have killed them.

[2] **Sample answer:** They would not have had any food.

[3] **Sample answer:** The meat-eating dinosaurs would not have had any plant-eating dinosaurs for food.

[4] **Sample answer:** If dinosaur eggs and young dinosaurs were eaten, there would have been fewer dinosaurs to have young. If other animals ate the same food the dinosaurs ate, the dinosaurs would not have had enough food to eat to stay alive.

[5] **Sample answer:** By studying parts of dinosaurs that are dug up.

When a dinosaur died, the soft parts of its body soon decayed, or broke down. Skin and muscle are such parts. But the hard parts of its body, such as bones and teeth, were sometimes left behind. In time, the bones and teeth became buried in the ground. After many years, things in the soil made some of these bones and teeth even harder. That is, they became *fossils* [FOS-uhlz].

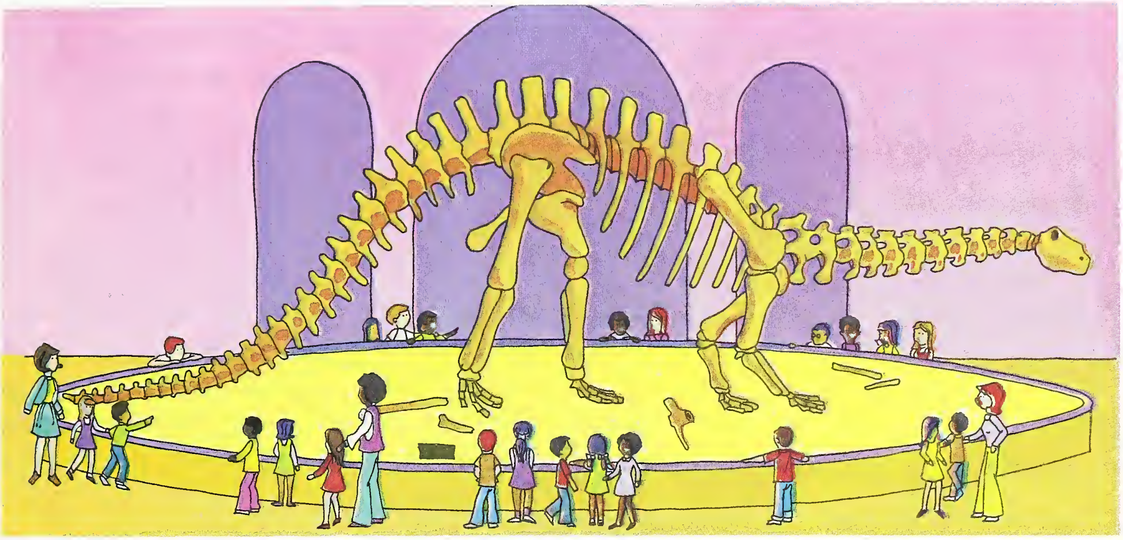
Through the years, people have dug up many fossil bones and teeth of dinosaurs. When enough fossil bones and teeth from a dinosaur

This man is carefully removing a fossil bone from a rock. Why do you think this must be done carefully?

Sample answer for the caption: So the fossil bones are not damaged.

have been found, they can often be put together to make a skeleton. From this skeleton, people can find out many things about a dinosaur. One thing people might find out is the kind of food a dinosaur most likely ate. They may also find out about how much a dinosaur weighed. What other things might people be able to find out about a dinosaur by studying its skeleton? [1]

[1] **Sample answer:** How tall they were and how long they were.



Some interesting questions about dinosaurs

Though there are no dinosaurs living now, many people are interested in them. Some of the questions people often ask about dinosaurs are found on page 56. Maybe you will find the answers interesting.

Suggested activity: After the pupils have read the information about fossil bones and teeth on pages 54 and 55, you may wish to take the pupils on a field trip to a museum to see some fossil skeletons of dinosaurs.

Exploring on Your Own

There were many fish that lived during the time the dinosaurs lived. See if you can find out what these fish were like. You might use reference books to help you. Look under the heading *fish* or *prehistoric animal*.

How big was the biggest dinosaur? The biggest plant-eating dinosaur was almost as long as a quarter of a football field. It was taller than a three-story building. The biggest meat-eating dinosaur was almost as long as a semitrailer. It was about as tall as a two-story building.

How small was the smallest dinosaur? The smallest dinosaur was about the size of a chicken.

How big was a dinosaur's brain? Although most dinosaurs were very big, their brain was very small. One of the largest dinosaurs had a brain about the size of a walnut!

How long did a dinosaur live? Many of the large dinosaurs probably lived to be about 100 years old.

What were the dinosaurs' teeth like? Some plant-eating dinosaurs had as many as 2,000 teeth! But their teeth were so weak they would have easily broken had these dinosaurs eaten anything other than plants. One meat-eating dinosaur had strong, pointed teeth. They were about 18cm long.

What were some other animals that lived when the dinosaurs lived? There were many other animals that lived during the time the dinosaurs lived. There were turtles and snakes. There were birds with teeth and long tails. There was also a flying, dinosaurlike animal. Its wingspread was greater than the length of two full-size cars parked end to end!

Sample finding for "Exploring on Your Own": Many of the fish that lived during the time of the dinosaurs were covered with a heavy armor of bony plates and scales.

FINDING OUT

How are some fossils made?

You will need: flat pan such as a pie pan, soil, small objects such as a bone or leaf

Fossils are most often thought of as the hardened parts of something that lived long ago. But the imprint made by something that lived long ago is also a fossil.

- Put some soil in a pan. Mix the soil with enough water to make a soft mud.
- Gently press some of the small objects partway into the mud. Let the mud dry for about a day.
- Carefully lift the objects out of the mud.
- Have someone guess what objects you used to make your "fossil" imprints.
- Trade pans with someone. Look at the "fossil" imprints in that person's pan.

What objects do you think that person used to make the "fossils"?

A Second Look

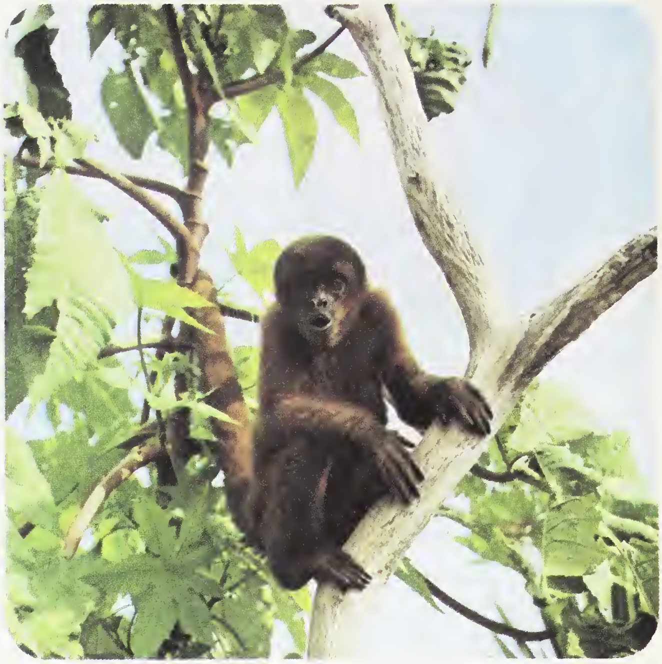
1. How do people learn about dinosaurs?
2. What kinds of food did the dinosaurs eat?
3. What things happened that may have caused the dinosaurs to die out?

Teaching helps for "Finding Out":
Processes used: observing, inferring, communicating.
Sample finding: The pupils will most likely identify what objects were used by observing the print the object made.
Sample answers for "A Second Look": 1. People learn about dinosaurs by studying their fossil bones and teeth. 2. Some dinosaurs ate meat and some ate plants. 3. One thing that may have caused the dinosaurs to die out was the drying up of swamps, which caused many of the plants the dinosaurs ate to die. Another thing that may have caused the dinosaurs to die out was the eating of the dinosaurs' eggs and young by other animals.

2 How are animals suited to where they live?

The dinosaurs were suited to living on flat, swampy land. The animals living today are also suited to where they live. In what ways do you think animals are suited to where they live?[1]

[1] **Sample answer:** Some animals have thick fur for living where it is cold. Fish have fins for swimming.



In what ways do you think this monkey is suited to living in its environment?

Desert animals

Have you ever been in a desert? Or perhaps seen pictures of a desert? If so, you know that a desert is very dry. Some deserts are very hot. There is very little food and water for desert animals to live on. Yet some animals are suited to living in this kind of environment.

Main concept of the chapter (pages 58–68): Animals are suited to where they live.

Performance objective: After studying the information provided in this chapter, the pupils should be able to

—give examples of ways in which animals are suited to where they live.

Important words: environment, gills, oxygen.

Sample answer for the caption: It has hands, feet, and a tail that help it climb trees.

Some of the body heat of the kangaroo rat is given off through its tail. How might this help the kangaroo rat live in a desert?

One desert animal is called the kangaroo rat. The kangaroo rat has a small body. So, it does not need much food or water. In fact, the kangaroo rat never drinks water. It gets the water it needs from the food it eats.

The kangaroo rat also stays underground most of the day. It hunts for food at night. How do these things show that a kangaroo rat is suited to living in a desert?[1]

Another small animal that lives in a desert is the horned toad. The horned toad is only about 9 cm long. Its skin is tough like an alligator's skin. This helps keep the horned toad from losing water from its body through its skin. Why might this be important to the horned toad?[2]

[1] **Sample answer:** Because there is very little water in most deserts and because the temperature is usually too hot for most animals to survive.

[2] **Sample answer:** The horned toad needs to keep a certain amount of water inside its body to stay alive.

Sample answer for the caption: It helps the kangaroo rat keep from becoming too warm.

Some other desert animals are not as small as the kangaroo rat or the horned toad. But even large desert animals, such as the camel, can usually go without water for several days.

What are some other desert animals you know of? How do you think they are suited to living in a desert?[1]

Exploring on Your Own

See if you can find out how a camel is able to go without food and water for several days. You might use reference books.

Polar-region animals

Some animals are suited to living in polar regions, or very cold places. Because these places are so cold, the animals must be able to keep warm.

One bird that lives in a polar region is called the *ptarmigan* [TAHR-mih-guhn]. The ptarmigan, like other birds, has many feathers. But it even has feathers on its feet! How do you think the feathers on a ptarmigan's feet are helpful to it?[2]

[1] **Sample answers:** Some snakes are suited to living in a desert because they can live underground where it is cool and because they have tough skin like the horned toad. Some spiders are suited to living in a desert because they need very little food and water. Also, they are small enough to be able to find shade always.

[2] **Sample answer:** They help keep the ptarmigan's feet warm and help the ptarmigan walk in snow.

Sample finding for "Exploring on Your Own": A camel can go without food for many days because it can use body fat it stores in its hump. A camel can go without water for many days because it sweats very little.

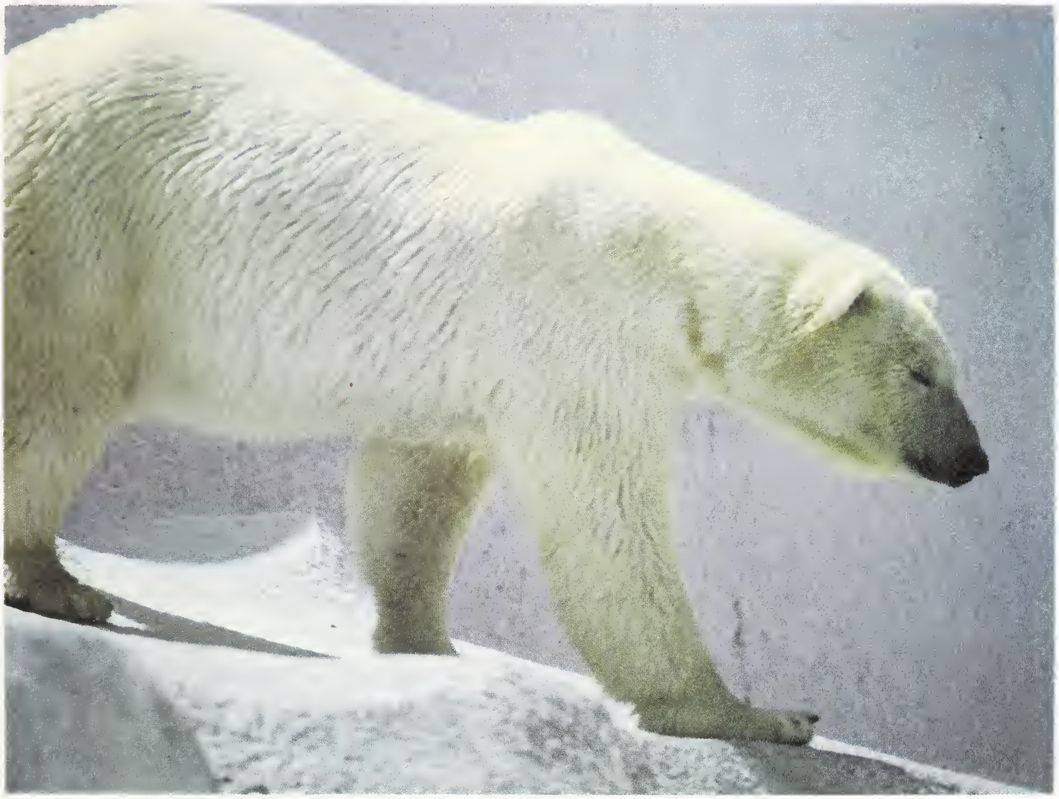
Suggested discussion: As the pupils look at the picture above, you might point out certain things about camels that show they are suited to living in a desert. You might tell the pupils that camels have large, flat feet, flaps of skin for closing their nostrils, and thick bushy eyebrows. You might then ask the pupils this question: How might these things help a camel live in a desert? (Sample answer: The flat feet keep a camel from sinking into the sand. The flaps of skin help keep the blowing sand out of a camel's nose. The eyebrows help keep the blowing sand out of a camel's eyes.)

A big animal that is suited to living in a polar region is the walrus. The walrus has tusks and a thick skin. It also has a thick layer of fat beneath its skin. How do you think the thick skin and the layer of fat help the walrus?[1]

The picture below shows another animal that is suited to living in a polar region. How do you think this animal is suited to living in a polar region?[2]

[1] **Sample answer:** They help keep the walrus warm.

[2] **Sample answer:** It has very thick hair to help keep it warm.

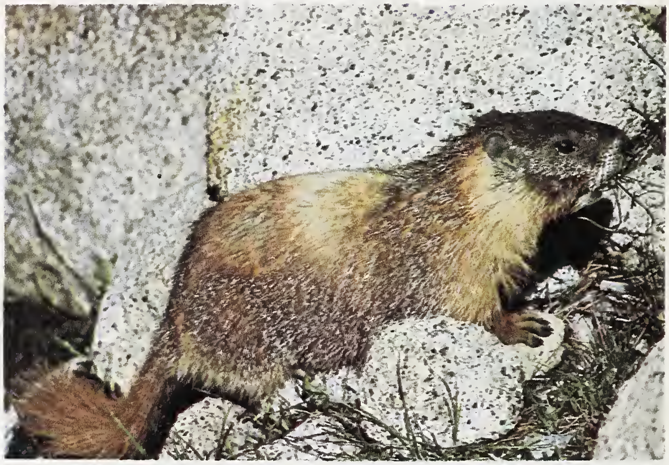


Suggested research and discussion: After the pupils have discussed "Desert animals" on pages 59 and 60, you may wish to ask them the following questions: Why do you think most desert animals are small rather than large? (Sample answer: The smaller the body, the less heat is picked up from the sun. Also, the smaller the body, the easier it is to get into some shade or to live underground.) Why do you think that some of the larger desert animals have large ears and long tails? (Sample answer: The large ears and long tails give off body heat so the animals do not become too warm.)

Mountain animals

Some animals are suited to living in mountains. Many of these animals are small and furry. Two such animals are the chinchilla and the Rocky Mountain pika. Because they are small, these animals can move about easily on the narrow ledges of mountains. How might their fur be helpful to these animals? [1]

[1] **Sample answer:** It helps keep them warm.



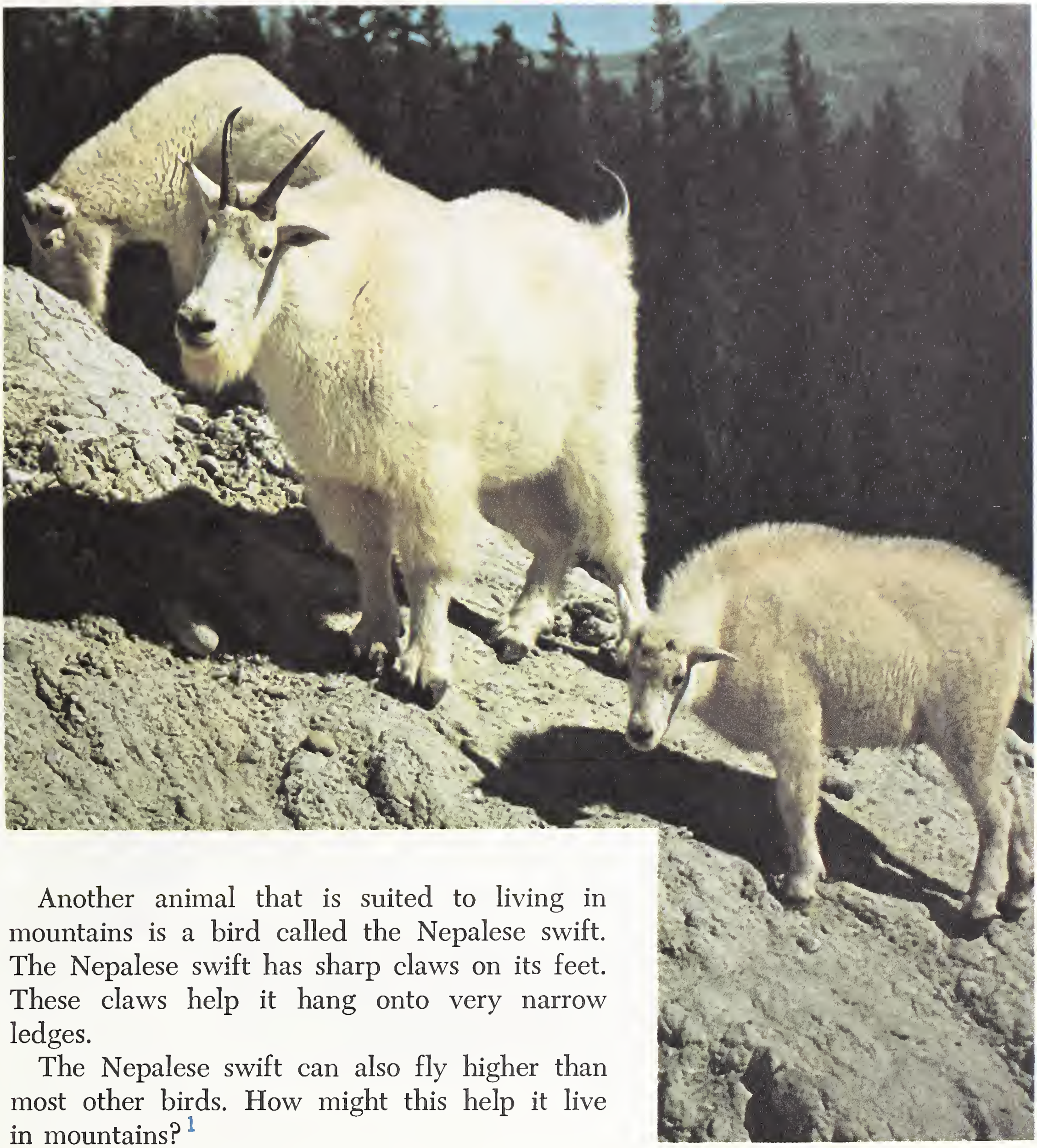
Another animal which is suited to living in mountains is the marmot. In what ways do you think the marmot is suited to living in mountains?

There are also some large animals that live in the mountains. One such animal is the Rocky Mountain goat. The Rocky Mountain goat has cuplike hooves. These hooves help keep it from slipping on the rocks and narrow ledges.

The Rocky Mountain goat also has a thick coat of hair. How might this help the Rocky Mountain goat live in mountains? [2]

[2] **Sample answer:** It helps keep the goat warm.

Sample answers for the caption: The marmot is small so it can move about easily on narrow ledges. The marmot is also furry, which helps keep it warm.



Another animal that is suited to living in mountains is a bird called the Nepalese swift. The Nepalese swift has sharp claws on its feet. These claws help it hang onto very narrow ledges.

The Nepalese swift can also fly higher than most other birds. How might this help it live in mountains?[1]

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[1] **Sample answer:** It is able to build nests away from most birds and other animals.

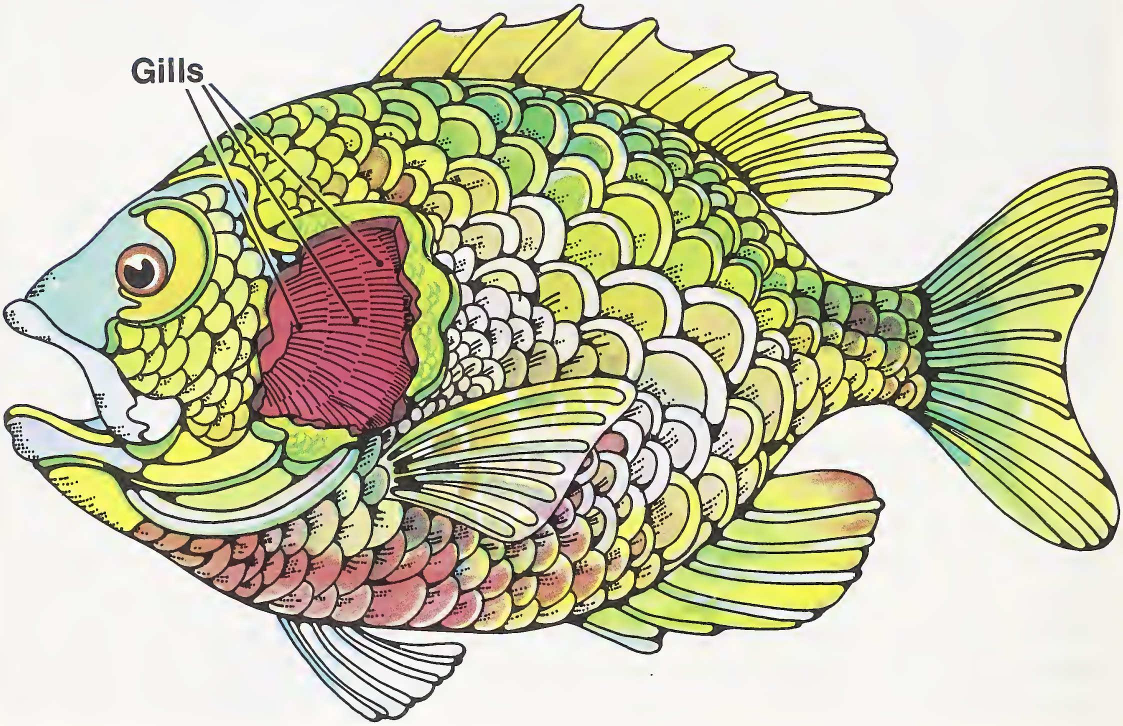
Suggested research and discussion: After discussing "Mountain animals," the pupils might find out about some other animals that live in mountains and how these animals are suited to living in mountains. For the pupils to do this, have them look in reference books under the heading *animal*. (Sample finding: A yak is a kind of ox that lives in mountains. It is very surefooted, which helps it move about on mountain ledges, and it is covered with thick hair, which helps keep it warm. An ounce is a kind of large cat that lives in mountains. It is very surefooted and it is covered with thick fur.)

Water animals

Have you ever watched a fish? If so, you may have seen the opening on each side of its body near the head. These openings lead to the fish's *gills*. A fish takes water into its mouth and forces the water over the gills. The gills take oxygen out of the water. This is how a fish is suited to breathing in water.

A fish also has fins and scales on its body. How do you think these things help a fish live in water?[1]

[1] **Sample answer:** The fins move the fish through the water and the scales make it easier for the fish to glide through the water.



Teaching helps for the picture above: You might point out to the pupils that the fish shown above has had the gill cover removed so the pupils can see the gills. But if the pupils were to look at a live fish, they would see a gill cover over the gills which moves out a little from the fish's body and then moves back in. You might then explain that when the pupils see the gill cover move out, the fish is forcing water over its gills and out of its body.

Suppose someone were to tell you that some animals that live in water can drown! As strange as this may seem, this is true.

One such animal is the whale. A whale is not a fish. It does not have scales on its body. Nor does it have gills. Instead, a whale has lungs. Because of this, a whale must swim to the surface of the water to breathe, just as you must do when you swim. But a whale does not breathe through its mouth as you do. It breathes through a small hole on top of its head.

A whale must also hold its breath when it goes underwater, just as you must. But a whale can hold its breath much longer than you can. Some whales can hold their breath for as long as an hour!

A whale also has fins. How do you think they help a whale live in water?[1]

There are many other kinds of animals that are suited to living in water. What other kinds of water animals do you know of? How might they be suited to living in water?[2]

Water and land animals

Some animals are suited to living both in water and on land. One such animal is the frog.

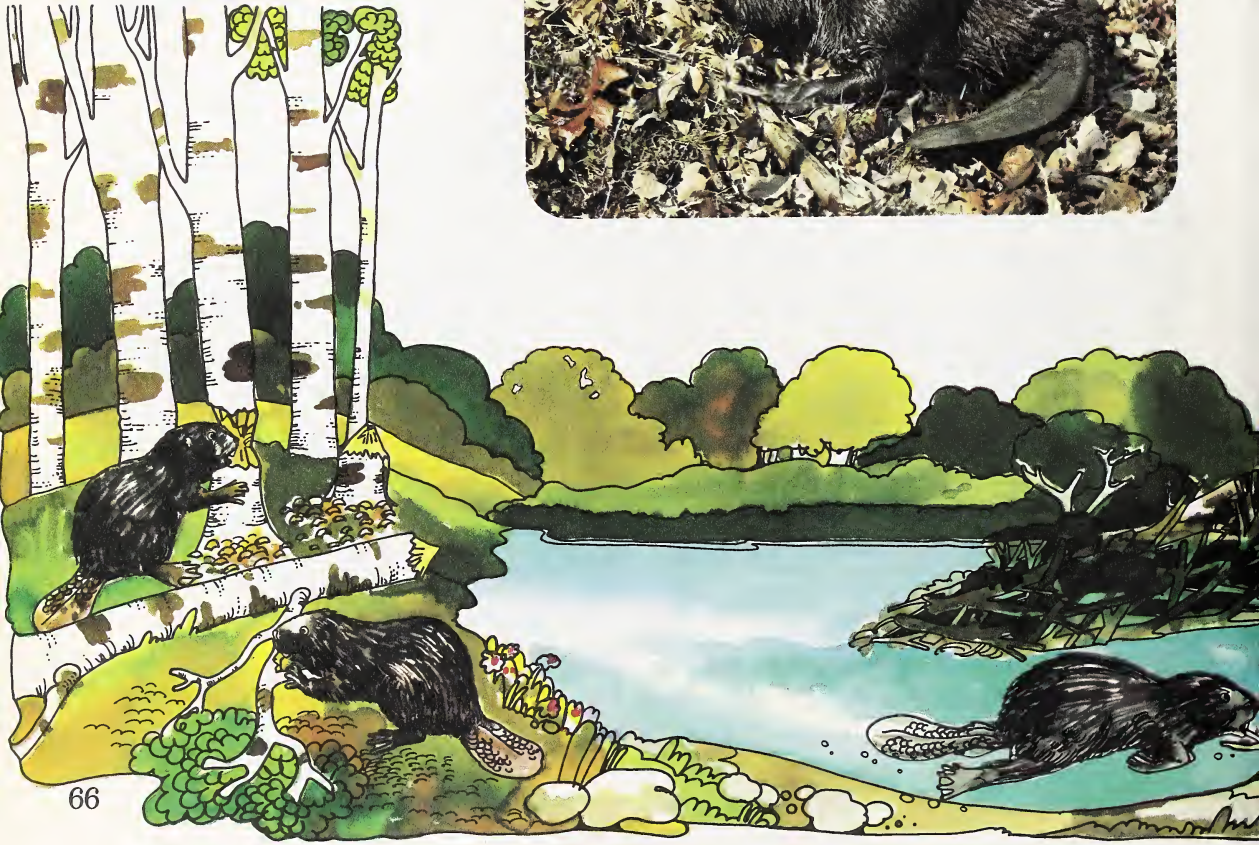
A frog has lungs. It breathes air as you do. A frog also has legs and feet. So, it can move about on land. But a frog's feet are webbed. How might this help a frog move about in water?[3]

[1] **Sample answer:** They help the whale swim.

[2] **Sample answers:** There are dolphins. They have fins to help them swim. There are lobsters and crabs. They can breathe under water. There are water snakes. They have a fin to help them swim.

[3] **Sample answer:** The webbed part of a frog's foot enables the frog to push against more water than if the foot were not webbed.

Another animal that is suited to living in water and on land is the beaver. A beaver has lungs. But while underwater, it may hold its breath for as long as fifteen minutes!



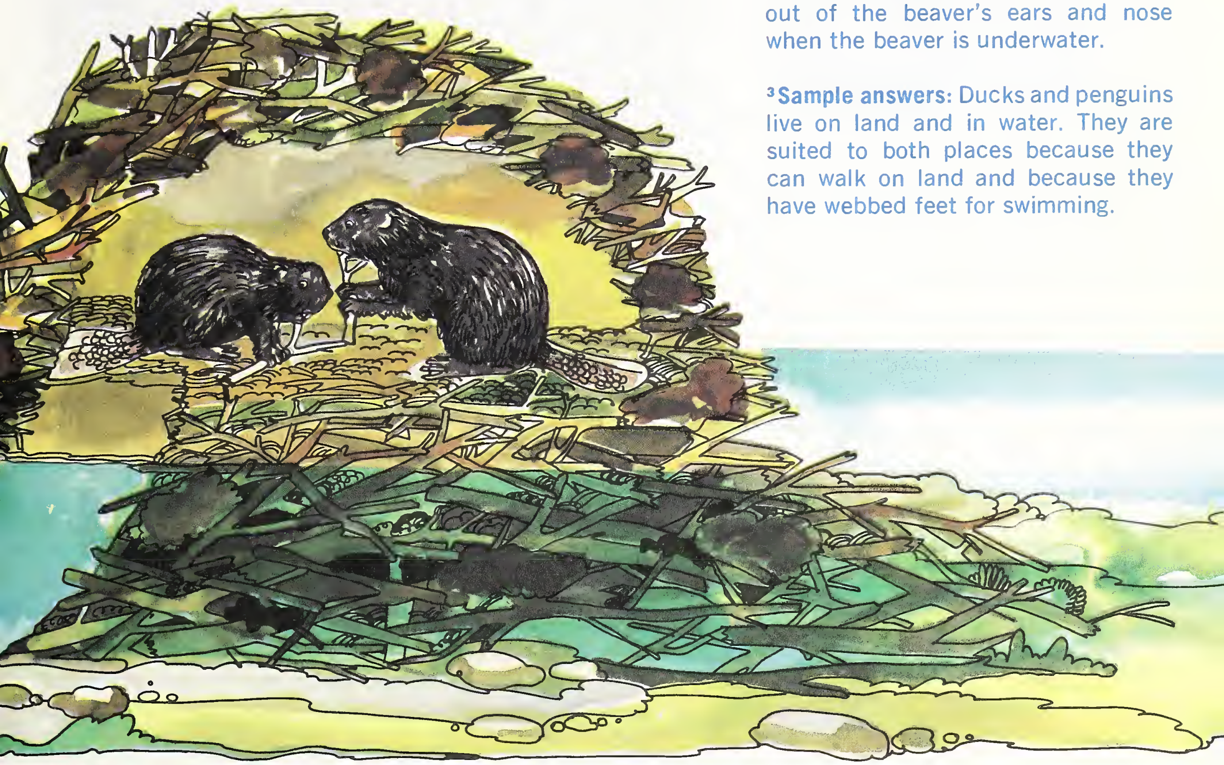
Teaching helps for the picture above: You may wish to use the picture above to point out some of the things which show that a beaver is suited to living in water and on land. Some things you might point out are the webbed hind feet and the paddle-shaped tail of the beaver. These things help the beaver swim. But the beaver also has transparent eyelids in addition to regular eyelids. These transparent eyelids enable the beaver to swim with its eyes open. Also the beaver has a flap of skin behind its front cutting teeth which the beaver closes when it carries pieces of wood while swimming. You might then ask the pupils the following question: How might this flap of skin help a beaver when swimming? (Sample answer: It keeps water from getting into the beaver's mouth when it is swimming and carrying something with its cutting teeth.)

A beaver also has legs and feet. So, it is able to move about on land. But the beaver's hind feet are webbed. How might this help a beaver move about in water?[1]

A beaver has a tail that is shaped like a paddle. A beaver uses its tail to steer itself through the water.

A beaver also has small flaps of skin it uses to close its nose and ears. How might this help a beaver when it is underwater?[2]

What are some other animals you know of that live in water and on land? How do you think they are suited to living in water and on land?[3]



Exploring on Your Own

The alligator is another animal suited to living in water and on land. See if you can find out how an alligator is suited to living in water and on land. You might use reference books to help you.

[1] **Sample answer:** The webbed feet enable the beaver to push against more water than if they were not webbed. This helps the beaver move about more easily in the water.

[2] **Sample answer:** The flaps keep water out of the beaver's ears and nose when the beaver is underwater.

[3] **Sample answers:** Ducks and penguins live on land and in water. They are suited to both places because they can walk on land and because they have webbed feet for swimming.

Sample finding for "Exploring on Your Own": The alligator has feet so it can walk about on land, but the feet are webbed for swimming. The alligator also has a long, strong tail which it uses for swimming.

FINDING OUT

How is a frog or a salamander suited to living in water and on land?

You will need: 2 or 3 frogs or salamanders and food for them (from a pet store), container such as a small fish tank, rocks, and pebbles

- Put the rocks and pebbles into the fish tank as shown.
- Put some water in the tank, but do not cover the rocks. The animals must be able to crawl out of the water and onto the "land."
- Feed the animals a very small amount of food each day or two.
- Change the water in the tank every 3 or 4 days.
- Watch your animals for a while each day.

How are these animals suited to living in water and on land?

A Second Look

1. How are some animals suited to living in a desert? In a polar region? In mountains?
2. How is a fish suited to living in water?
3. How is a whale suited to living in water?
4. How is a frog suited to living in water and on land?

Teaching helps for "Finding Out":
Processes used: observing, communicating.
Sample findings: The pupils may observe that frogs and salamanders can walk about on land, but they can also swim.

Sample answers for "A Second Look": 1. Some animals are suited to living in a desert because they drink very little water and because they are small. Some animals are suited to living in a polar region because they have a heavy coat of hair or fur and because they have a thick layer of fat under their skin. Some animals are suited to living in mountains because they have cuplike hooves or because they are very small. 2. A fish is suited to living in water because it has fins, scales, and gills. 3. A whale is suited to living in water because it has fins. 4. A frog is suited to living in water because it has webbed feet. A frog is suited to living on land because it can hop about and because it has lungs.

3 How do animals protect themselves?

Have you ever tried to walk very close to a bird? If so, the bird most likely flew away. Why?

Many animals, such as birds, are hunted by other animals for food. So, animals that are hunted have ways of protecting themselves. A bird might protect itself by flying away. How else might animals protect themselves? [1]

[1] **Sample answer:** Cats and dogs might run away or use their teeth or claws.

In what ways, do you think, might this Brazilian porcupine protect itself?

Hard-to-see animals

Suppose you were to visit a zoo. If you did, you would find that many animals are easy to see when they are in a zoo. Do you think they would be as easy to see when they are in their natural environment? Why or why not? [2]

[2] **Sample answers:** No. Because the colours of an animal's fur, hair, skin, or feathers usually blend with the colours of the things around the animal.

Main concepts of the chapter (pages 69–78):

Some animals protect themselves by looking like things or other animals in the environment or by using chemicals, hooves, claws, teeth, tusks, or armour.

Other animals protect themselves by jumping or by running.

Sample answers for the caption: With its quills. By climbing trees.

Performance objective: After studying the information provided in this chapter, the pupils should be able to

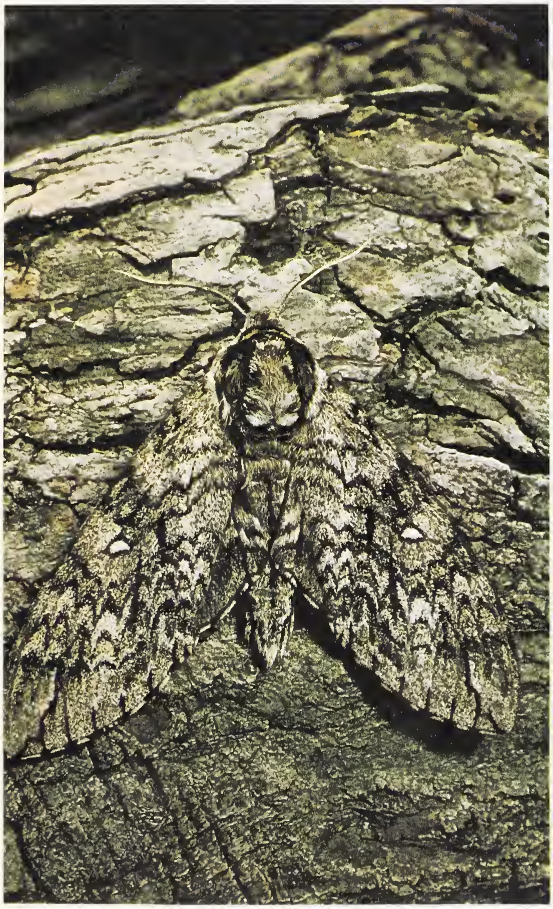
—list at least four different ways in which animals protect themselves.

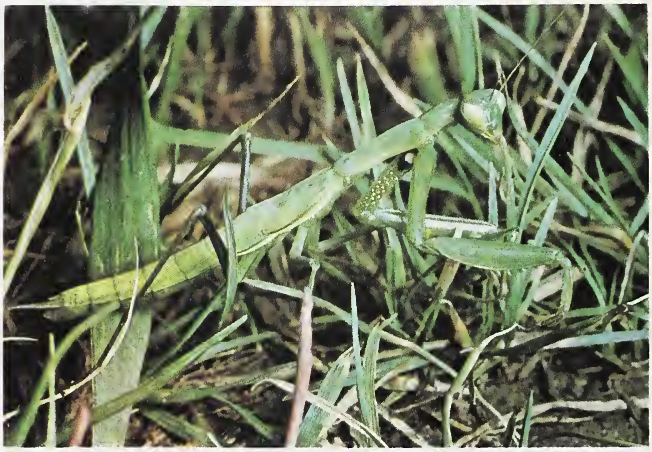
Important word: chemicals.

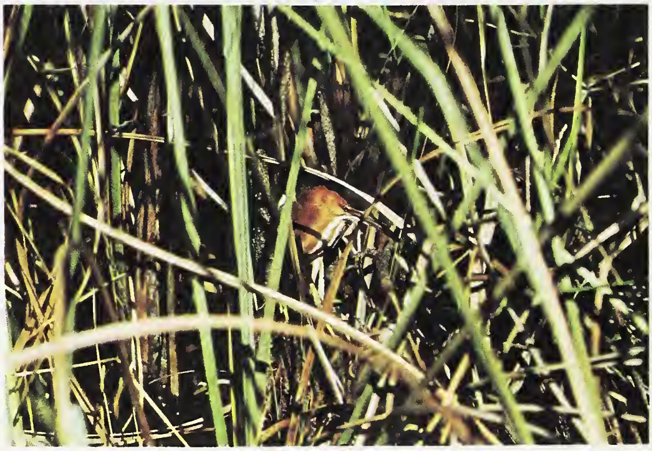
The pictures on this page show some animals in their natural environment. See if you can find an animal in each picture.

Some animals are about the same colour as the things around them. Other animals are about the same shape as the things around them. How might the colour or shape of such an animal help protect it? [1]

[1] **Sample answer:** The colour or the shape makes the animal hard to see.







Teaching helps for the picture above: A moth is hidden in the picture on the left. A praying mantis is hidden in the top right picture. A bittern is hidden in the bottom right picture. Each animal is pointed out by a blue arrow.

FINDING OUT

Is it hard to see something when it is the same colour as the things around it?

You will need: different-coloured toothpicks or small pieces of different-coloured paper (be sure some are green), small area of grass

- Spread the toothpicks out in the grass. Be sure to use about 5 of each of 3 or 4 different-coloured toothpicks.
- Have someone try to find as many toothpicks as possible within 2 minutes.

How many toothpicks of each colour did your partner find?

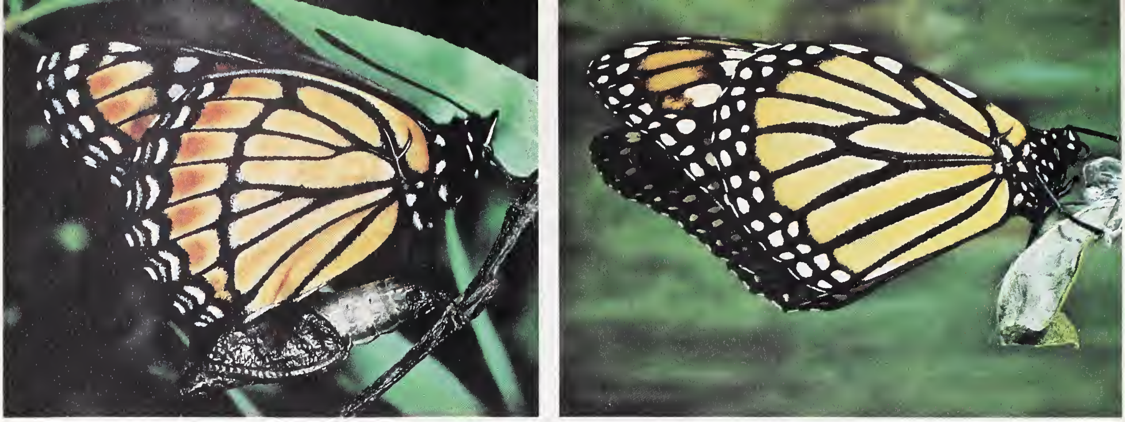
- Have your partner put the toothpicks in the grass. See how many you can find.

How many toothpicks of each colour did you find? Which colour toothpick was the hardest for you and your partner to find? Why do you think it was the hardest colour to find?
Why do you think some animals are hard to see in their natural environment?

Look-alike animals

Have you ever seen any butterflies? If you have, you know that it is often easy to tell one kind from another. But the monarch butterfly and the viceroy butterfly look very much alike.

Teaching helps for "Finding Out":
Processes used: observing, comparing, using numbers, inferring.
Sample findings: The pupils will most likely observe that the green toothpicks were the hardest to find. They may say that the green toothpicks were the hardest to find because their colour was very similar to the colour of the grass. The pupils may infer from this that some animals are hard to see in their natural environment because the colour of the animals is about the same as the colour of the animals' surroundings.

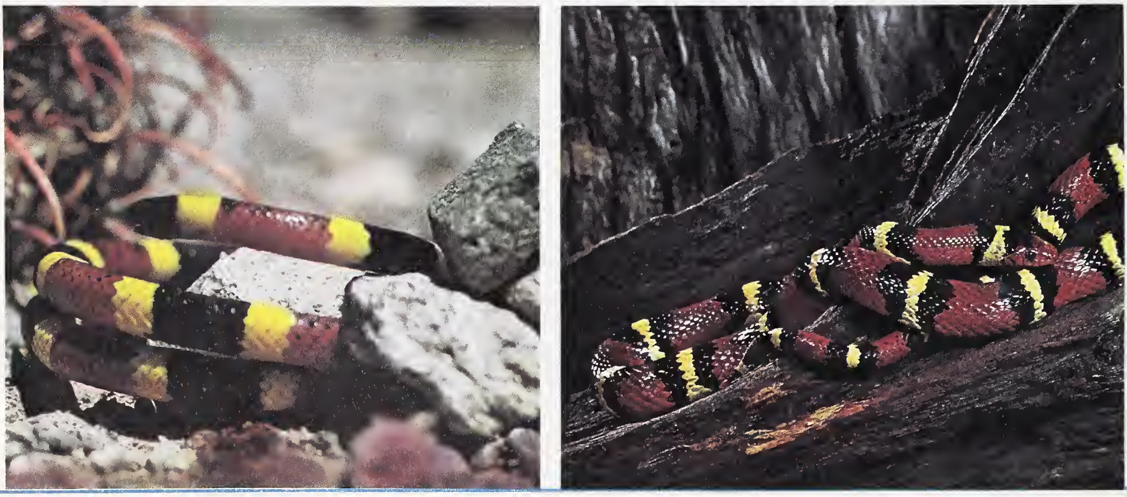


How is the viceroy butterfly (left) like the monarch butterfly (right)? How are they different?

Birds like to eat viceroy butterflies. But birds do not like to eat monarch butterflies. How might looking like monarch butterflies be helpful to viceroy butterflies? [1]

[1] **Sample answer:** Most birds will probably not try to eat a viceroy butterfly because it looks like a monarch butterfly.

How might it be helpful for the nonpoisonous king snake (right) to look like the poisonous coral snake (left)?



Sample answers for the top caption: Both butterflies have black and orange markings. The shape of their wings is a little different. The black markings on the wings are a little different.

Sample answer for the bottom caption: It would probably keep the king snake from being attacked by other animals.

Animals that use chemicals

Many animals protect themselves by using certain *chemicals* [KEHM-ih-kuhlz]. The poison that some snakes make is one such chemical. How do you think these snakes use their poison to protect themselves? 1

A skunk also protects itself with a chemical. When other animals get too close to a skunk, it sprays this chemical on them. Most animals will leave the skunk alone because the chemical has a very bad smell.

Some insects also use chemicals to protect themselves. What insects do you know of that use chemicals to protect themselves? 2

[1] **Sample answer:** They use their poison to kill an animal that attacks them.

[2] **Sample answer:** Bees, wasps, hornets.

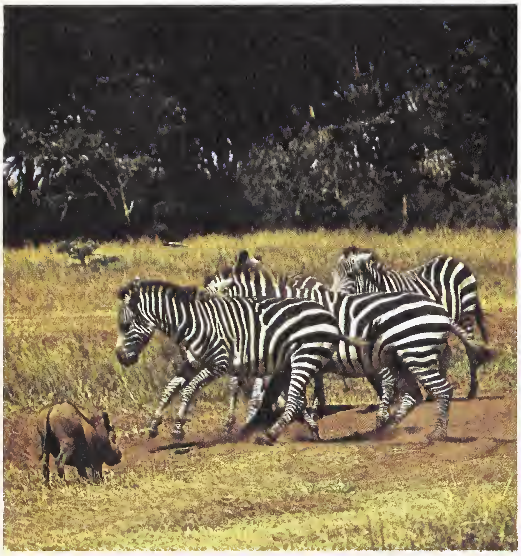
Suggested research and discussion: After the pupils discuss "Animals that use chemicals," you may wish to have them use reference books to find out about other animals that use chemicals to protect themselves. Then you might ask them the following questions: What are some other animals that use chemicals to protect themselves? How do they protect themselves? (Sample answers: A scorpion uses a stinger on its tail to release its poison. A Gila monster bites to release its poison.)

Animals with hooves or claws

Some animals use hooves or claws to protect themselves. The pictures on this page show some of these animals. How might these animals use hooves or claws to protect themselves?[1] What are some other animals you know of that use hooves or claws to protect themselves?[2]

[1] **Sample answer:** They could use their hooves for kicking and their claws for scratching.

[2] **Sample answer:** Horses use hooves to protect themselves. Lobsters use claws to protect themselves.

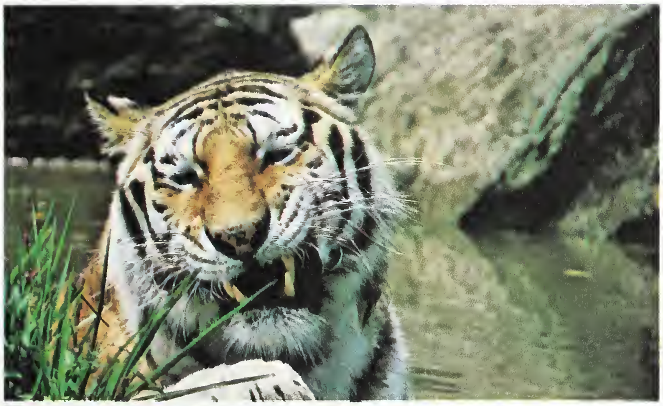


Animals with teeth or tusks

Some animals, such as dogs, have very sharp teeth. Others, such as elephants, have sharp tusks. These animals use their teeth or tusks to protect themselves. The pictures below show some animals that use teeth or tusks to protect themselves.

What are some other animals you know of that protect themselves with teeth or tusks?[1]

[1] **Sample answer:** Elephants protect themselves with their tusks. Lions protect themselves with their teeth.



Suggested discussion: After the pupils have discussed the material on pages 67–75, you might have the pupils once again look at the animals pictured above. Then have the pupils point out another way in which these animals might be protected besides those ways stated above. (Sample answer: The colouring of each of these animals can help it blend in with its surroundings.

Animals that jump or run

You most likely have seen a frog or a grasshopper jump. These animals jump to move about. But they also jump to protect themselves. What do you think makes these animals good jumpers? [1] What are some other animals you know of that jump to protect themselves? [2]

Some animals protect themselves by running. Many animals are good runners. But the cheetah is the fastest runner. A cheetah is one kind of cat. It is spotted and has long legs. Most cheetahs can run about 105 km/h for short distances.

The picture below shows an animal that protects itself by running. What are some other animals you know of that protect themselves by running? [3]

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[1] **Sample answer:** Their strong hind legs.

[2] **Sample answer:** Crickets, kangaroos, toads.

[3] **Sample answer:** Deer, squirrels, chickens.

Animals with armour

Many animals cannot move about well enough to protect themselves. Some of these animals are protected by armour. One such animal is the turtle. When it needs protection, it pulls its head and legs into its shell.

The pictures on this page and on the next page show some other animals that have armour. How are they protecting themselves? 1

[1] **Sample answer:** The snail is going back into its shell. The armadillo is curled up in a ball so only the hard part of its body is exposed.

Suggested activity: After the pupil's have read the information on pages 74–78, you may wish to have them collect pictures or draw pictures that would show some of the ways animals protect themselves. You might then have the pupils group their pictures according to the ways in which the animals protect themselves. Finally, you might have the pupils make a bulletin-board display with their pictures.

For You to Think About

Some animals, including the opossum, protect themselves by "playing dead." How do you think "playing dead" would help these animals protect themselves?

There are many other ways animals protect themselves besides those ways talked about in this chapter. In what other ways might animals protect themselves? 1

[1] **Sample answer:** Some might protect themselves by changing colour. Some might protect themselves by hiding.

A Second Look

1. In what way does the colour or shape of some animals help protect them?
2. How do some animals use chemicals to protect themselves?
3. What are some animals that jump or run to protect themselves?
4. In what other ways do animals protect themselves?

Sample answer for "For You to Think About": Most animals will not attack another animal when it plays dead.
Sample answers for "A Second Look": 1. The colour or shape of some animals helps protect them because their colour or shape makes the animals hard to see. 2. Some snakes use a chemical to kill an animal that attacks them. A skunk sprays a chemical that smells bad on animals that attack it. 3. Some animals that jump or run to protect themselves are frogs, grasshoppers, giraffes, and cheetahs. 4. Some other ways animals protect themselves are by looking like other animals, by using hooves or claws, by using teeth or tusks, or by using armour.

4 What can people do to protect animals?

Have you ever noticed how many kinds of animals live in your neighbourhood? Are there dogs? Squirrels? Birds? If not, what kinds of animals live in your neighborhood?

Why are some animals dying out?

Two or three hundred years ago, there were most likely many more kinds of animals living where you now live. In fact, there were more than two hundred different kinds of animals living in the world then than there are now. But these animals have all died out. And today there are over a thousand different kinds of animals that are in danger of dying out. Why do you think some kinds of animals have died out?[1] Why do you think some kinds of animals are in danger of dying out?[2]

[1] **Sample answer:** Because they could not find the food they needed.

[2] **Sample answer:** Because they do not have enough land to live on.

Main concepts of the chapter (pages 78–91):
Some animals are in danger of dying out because of overcrowding, overhunting, or pollution.
People are trying to protect animals by saving some land for them, by controlling hunting, and by stopping pollution.
Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—list three reasons why some animals are in danger of dying out;
—state three ways in which people are trying to protect animals.
Important word: polluted.

Exploring on Your Own

As you may know, many kinds of animals have died out during the last few hundred years. See if you can find out why these animals died out. To do this, you might use reference books. Look under the headings *passenger pigeon, elephant bird, dodo, quagga,* and *animal.*

Changes in the land. As you may know, animals live where they can find the things they need to stay alive. These things include plants, water, and other animals.

A few hundred years ago, animals could easily find these things. Much of the land was wilderness. That is, few people were living on it. But through the years the number of people grew larger. So, more and more of the land was used by people for building cities and for farming. How might these things have been harmful to the animals? [1]

Today, even more land is being used by people. This is causing many animals to be crowded into smaller and smaller areas of land. The animals eat the food that grows on the land faster than it can grow back. Because of this, many animals are in danger of dying out. Why else might some animals be in danger of dying out? [2]

[1] **Sample answer:** They were harmful because the animals had less and less land to live on.

[2] **Sample answer:** Because some are being overhunted.

How is land being used in this picture? Might such use of land be harmful to animals? Why or why not?

Sample finding for "Exploring on Your Own": The passenger pigeon, elephant bird, dodo, and guagga died out because they were overhunted. **Sample answers for the caption:** The land is being used to make a highway. Its use might be harmful in that there will be less land for the animals to use and less freedom of movement for the animals.

FINDING OUT

What does overcrowding do to mealworms?

You will need: about 24 mealworms, 4 small glass jars, lettuce, dry cereal such as cornflakes or bran flakes

For faster results, you might use grasshoppers in place of mealworms. If you do use grasshoppers, you will need about 12 of them. Feed them green, leafy plants instead of dry cereal.

- Place a small piece of lettuce (for moisture) and 2 or 3 pieces of dry cereal in the bottom of each jar.
- Put 6 mealworms in each jar. Cover the opening of each jar with something that will let air in.
- About every 2 or 3 days, put a fresh piece of lettuce in each jar and some more dry cereal, if needed. Do this for a week or so.

Are the mealworms getting bigger?

- If not, keep feeding the mealworms until they begin to grow.
- After the mealworms begin to grow, put 18 of them into one jar. Leave 6 mealworms in another jar. Every 2 or 3 days add the same amount of food to each jar as you did before. Do this for a week or so.

Does overcrowding affect the mealworms? If so, how can you tell?

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring, communicating.
Sample findings: The pupils will most likely observe that the mealworms grow larger in a week or two. After the 18 mealworms have been in the one jar for a week or so, the pupils may observe that these mealworms have not grown, whereas the 6 mealworms in the other jar have grown. The pupils may infer from this observation that overcrowding does affect mealworms because they do not have enough food to grow.

Overhunting. People have hunted animals for many years. Years ago, animals were hunted mostly for food. So most animals were not overhunted. That is, too many were never killed at one time. Most animals were able to have enough young to keep their kind alive.

But then people began to hunt animals for other reasons. One reason was because their hides were worth money. One animal that was hunted for its hide was the buffalo. So many of these animals were hunted that they almost died out. Why do you think buffalo hides were worth money? [1]

[1] **Sample answer:** They were used for clothing.

Prairie dogs live in holes they dig in the ground. These holes are often harmful to cattle and horses. How might this be so?

Another reason some animals were hunted was because people thought they were pests. One such animal was the prairie dog. The prairie dog ate the same food that cattle ate. Because people wanted their cattle to have this food, prairie dogs were hunted until they almost died out.

Many other animals are in danger of dying out because of overhunting. Which of these animals do you know of?[1]

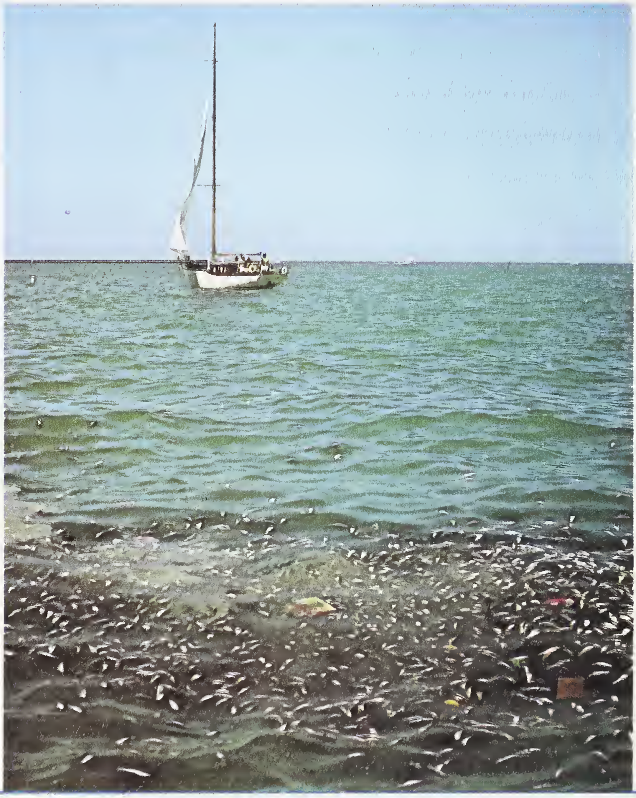
[1] **Sample answer:** Gorilla, tiger, grizzly bear, alligator.

Sample answer for the caption: Cattle and horses sometimes break their legs when they step into these holes.

Pollution. For years, cities and factories have emptied wastes into lakes, rivers, and oceans. For this reason, many bodies of water are now *polluted*, or unclean. How might polluted water be harmful to animals? [1]

Smoke from cities, factories, cars, and trucks has polluted the air in many places. How might polluted air be harmful to animals? [2]

For many years, people have used chemicals to help keep insects from eating certain plants. Some of these chemicals are sprayed on these plants to kill the insects. But many other animals also eat these plants. How might this be harmful to these animals?[3]



[1] **Sample answer:** It might make animals sick or kill them.

[2] **Sample answer:** It might make animals sick or kill them.

[3] **Sample answer:** It might kill them.

Suggested research and discussion: After the pupils have discussed "Pollution," you may wish to have them find out about a kind of pollution which is harmful to fish. For the pupils to do this, have them look in reference books under the heading *thermal pollution* or *water pollution*. Then you might ask the pupils the following question: How does thermal pollution harm fish? (Sample answer: Thermal pollution heats the water in lakes or rivers, causing the water to lose some of its oxygen. When there is less oxygen in the water than normal, many kinds of fish die.)

What is being done to help save animals?

Many kinds of animals are in danger of dying out. But people are trying to save as many kinds of animals as they can. How do you think this is being done?[1]

Saving some land for animals. Throughout the world, there are many national parks. Many different kinds of animals live in these parks. There are also people who work in the parks. Some of these people try to make sure the animals can find the things they need to stay alive. Some of these people also try to make sure that the animals are not hunted.

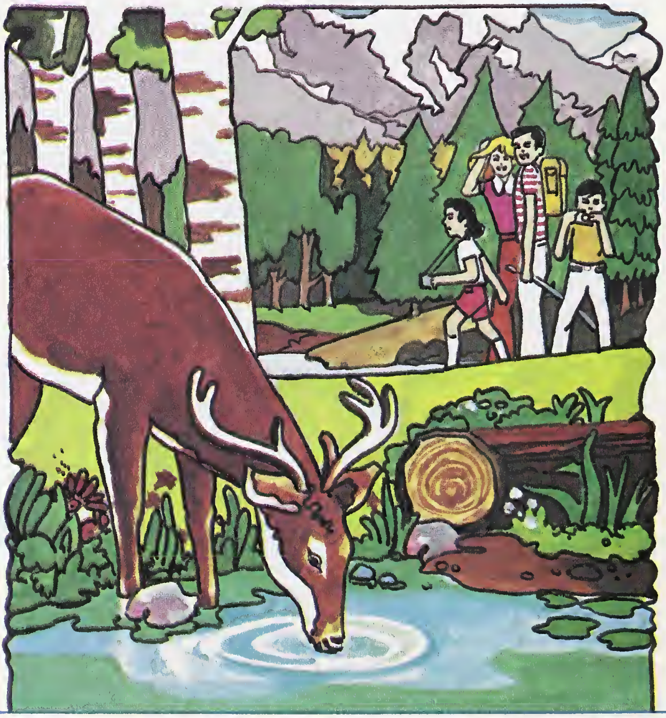
What else do you think people are doing to help save animals?[2]

For You to Think About

Do you think it is important that people try to save as many kinds of animals as they can? Why or why not?

[1] **Sample answer:** People are beginning to save some land for the animals.

[2] **Sample answer:** People are beginning to control pollution.



This picture and those on the next page show some national parks. Many kinds of animals are protected in national parks. What are some national parks you know of?

Sample answers for "For You to Think About": Yes. Because animals are an important part of life on the earth.

Sample answer for the caption: Jasper National Park, Serengeti National Park, Pacific Rim National Park, Cape Breton Highlands National Park.

Protecting animals from being overhunted. Many people enjoy hunting and fishing. And as you may know, most animals are able to keep their kind alive if they are not overhunted.

When people found that overhunting might cause some animals to die out, certain laws were passed. These laws help control hunting and fishing. They do this by stating how many of one kind of animal can be hunted or caught. Do you think it is helpful to have these laws? Why or why not?[1]

The pictures on this page and the next page show some animals that are protected by law. What are some other animals you know of that are protected by law?

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[1] **Sample answers:** Yes. Because these laws help keep animals from being overhunted.

Sample answer for the caption: Deer, elephant, bear, buffalo.

Stopping pollution. Many cities and factories have now stopped polluting bodies of water. Cities and factories have also found ways to keep from polluting the air. And many cars and trucks have special things on them that help keep the air clean. Also, some of the chemicals sprayed on plants that are harmful to animals are no longer being used. How might these things help save animals?[1]

[1] **Sample answer:** By providing the animals with water, air, and food that are not harmful to the animals.

Suggested research: After discussing the material on pages 86–89, the pupils might find out about how some people have helped keep certain animals from dying out. For the pupils to do this, have them look in reference books under the headings *whooping crane* and *osprey.* (Sample findings: The whooping cranes were saved when laws were passed that kept people from robbing the nests, from shooting the birds, and from changing the natural environment in which the birds nested and fed. The ospreys were saved when a chemical—DDT—used to kill insects could no longer be used.)

What can you do to protect animals?

Listed below are four pairs of statements. One statement in each pair tells of something you can do to help protect animals. Which statement in each pair tells of something you can do to help protect animals? How might doing these things help protect animals?[1]

There are many other things people can do to help protect animals. What might some of these things be?[2]

Choosing to Protect Animals

I am going to throw this leftover food and empty soda can into the lake.
I am going to put this leftover food and empty soda can into a trash can.

I am going to put the campfire out before we leave.
I am going to let the campfire go out by itself.

I am going to leave the frog here.
I am going to take the frog home with me.

I am going to pull the bird's nest down so I can look at it more closely.
I am going to leave the bird's nest alone because there might be eggs in it.

[1] **Sample answers:** The second statement in the first pair. Because this would keep the water in the lake from becoming polluted. The first statement in the second pair. Because it might help prevent a fire that could destroy the food the animals need. The first statement in the third pair. Because frogs as well as all other animals are needed to keep a balance of nature. The second statement in the fourth pair. Because animals need to be able to keep their kind alive.

[2] **Sample answer:** Keep their pets from running loose. Not spray trees and other plants with sprays that could be harmful to animals if they were to eat parts of the trees or other plants.

Teaching helps for the picture on page 91: You may wish to have the pupils look at this picture and then answer the following question: What are these boys and girls doing that might help protect animals? (Sample answer: The two girls are helping prevent a forest fire by making sure their campfire is out. The boy is helping his pet stay healthy by having it checked by a veterinarian. The boys and girls are helping control water pollution by taking trash out of the stream.)

A Second Look

1. Why are some animals in danger of dying out?
2. What are some things people can do to help save animals?

Sample answers for "A Second Look": 1. Some animals are in danger of dying out because of changes in the land, overhunting, and pollution. 2. Some things people can do to help save animals are to save some land for animals, to protect animals from overhunting, and to stop pollution.

Workers Who Use Science

Many people are interested in protecting animals. One such person is the *fish and wildlife specialist* [SPEHSH-(uh-)luhst].

A fish and wildlife specialist does many things to help animals stay alive. One thing this person does is study an area where animals live. By doing this, the fish and wildlife specialist can tell if there is enough food and water for these animals. If there is not enough food, the fish and wildlife specialist might have food brought in. Or this person might have some of the animals moved to places where they can find food and water.

Another thing a fish and wildlife specialist does is help make sure that people do not overfish and overhunt. This person might do this by helping to set up hunting and fishing laws.

To find out more about the work of a fish and wildlife specialist, try to find the answers to these questions:

What is tagging and banding, and how are they helpful in protecting animals? [1]
What other things does a fish and wildlife specialist do to help protect animals? [2]

Along with sources of your own, writing to the following source may help you answer the questions: Department of the Environment, Environmental Management Service, Ottawa, Ontario K1A 0H3.

Sample answers for "Workers Who Use Science":

[1] Tagging and banding are ways of marking birds and other animals for identification. Having a way to identify individual animals enables a fish and wildlife specialist to know where each animal or groups of animals are. It also helps a fish and wildlife specialist know if the animals are finding enough food to eat, water to drink, and places to live.

[2] Another thing a fish and wildlife specialist might do is to move some animals to other areas if a certain area becomes too crowded. Still another thing a fish and wildlife specialist might do is to give medicine to animals when they are sick.

Reviewing the Main Ideas

Dinosaurs were animals that lived long ago when most of the earth was flat and swampy.
It is thought that dinosaurs died out because their environment changed.
People learn about dinosaurs by studying their fossil bones and teeth.
Animals are suited to where they live.
Animals have many ways of protecting themselves.
Some animals are in danger of dying out because of overcrowding, overhunting, or pollution.
People are trying to protect animals by saving some land for them, by controlling hunting, and by stopping pollution.

Reading About Science

Brady, Irene. *Beaver Year.* Markham, Ontario: Houghton Mifflin Canada Ltd., 1976.
Childcraft—The How and Why Library. The 1974 Childcraft Annual. *Animals in Danger.* Don Mills, Ontario: Addison-Wesley (Canada) Ltd., 1974.
Garcia, Claire. *The Peanut Plan.* Toronto, Kids Can Press, 1975.
Stewart, Darryl. *Canadian Endangered Species.* Agincourt, Ontario: Gage Publishing Limited, 1974.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 94.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to animals and their environment. Such articles might be found in reference books under the headings *animal* and *wildlife conservation.*

Testing for Understanding

Ideas to Check

On your paper write *T* for each sentence below that is true. Write *F* for each sentence that is false.

T 1. At one time, there were dinosaurs living almost everywhere on the earth.
F 2. Fish are suited to living in water because of their fins, scales, and lungs.
T 3. Some animals are protected by armour.
T 4. Some animals protect themselves by jumping or running.
F 5. There is little that people can do to help keep some animals from dying out.
T 6. Some animals are in danger of dying out because they have been crowded into smaller and smaller areas of land.

Words to Use

Write on your paper the word that best fits in each blank below. Choose from these words: *environment, fossil, gills, lungs, chemicals, polluted.*

1. A whale and a frog use ____ for breathing. lungs
2. People learn about dinosaurs by studying their ____ bones and teeth. fossil
3. Some animals use ____ to protect themselves. chemicals
4. A dinosaur's ____ was made up of swampy land, plants, and other animals. environment
5. When water and air are made unclean, they are said to be ____. polluted

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Animals and Their Environment" are provided for you on page T17 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22.

Having Fun with Science

What Animal Am I?

1. Although I need water, I never drink water.
2. Although I live only in water, I can drown.

Animal Safari

Each sentence below has the name of one animal in it that you may have read about in this unit. But the names are hidden. The first sentence has the animal's name underlined to help you. See if you can find each animal's name in the rest of the sentences.

1. That hat of Roger's is very funny.
2. The mailman came later than usual.
3. I saw them a few minutes ago at the drugstore.
4. My father told me I would be a very good swimmer.

Things to Do

1. The next time you have some chicken to eat, save the bones. Boil them in soapy water to remove any meat that might still be on them. Try to put the bones together to make a skeleton. You will need to use glue or tape to hold the bones together.

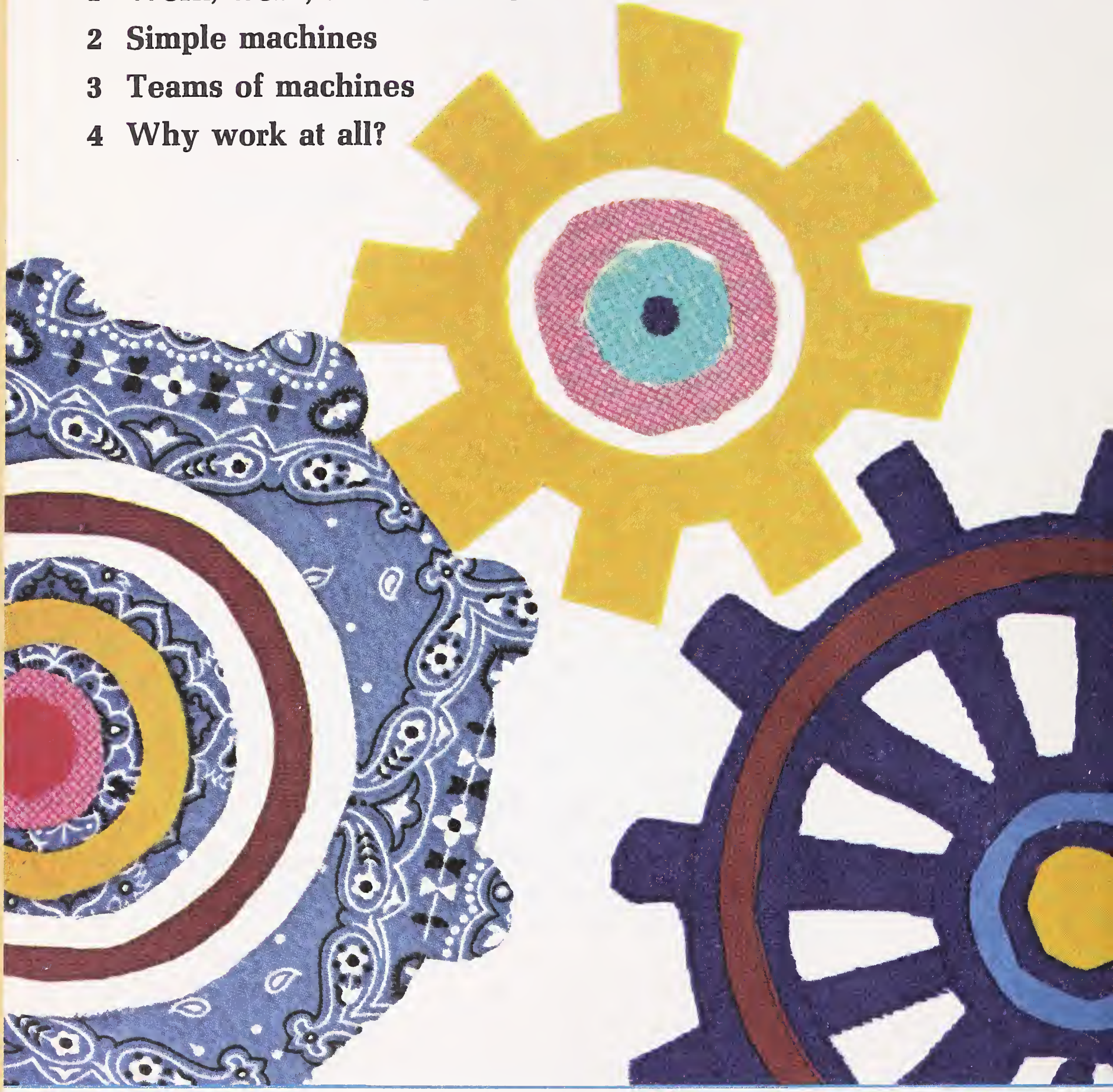
2. Watch the animals that live in your neighbourhood. See if you can tell how they protect themselves.

For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of the unit "Animals and Their Environment." You may also wish to encourage the pupils to make up additional activities related to animals and their environment.

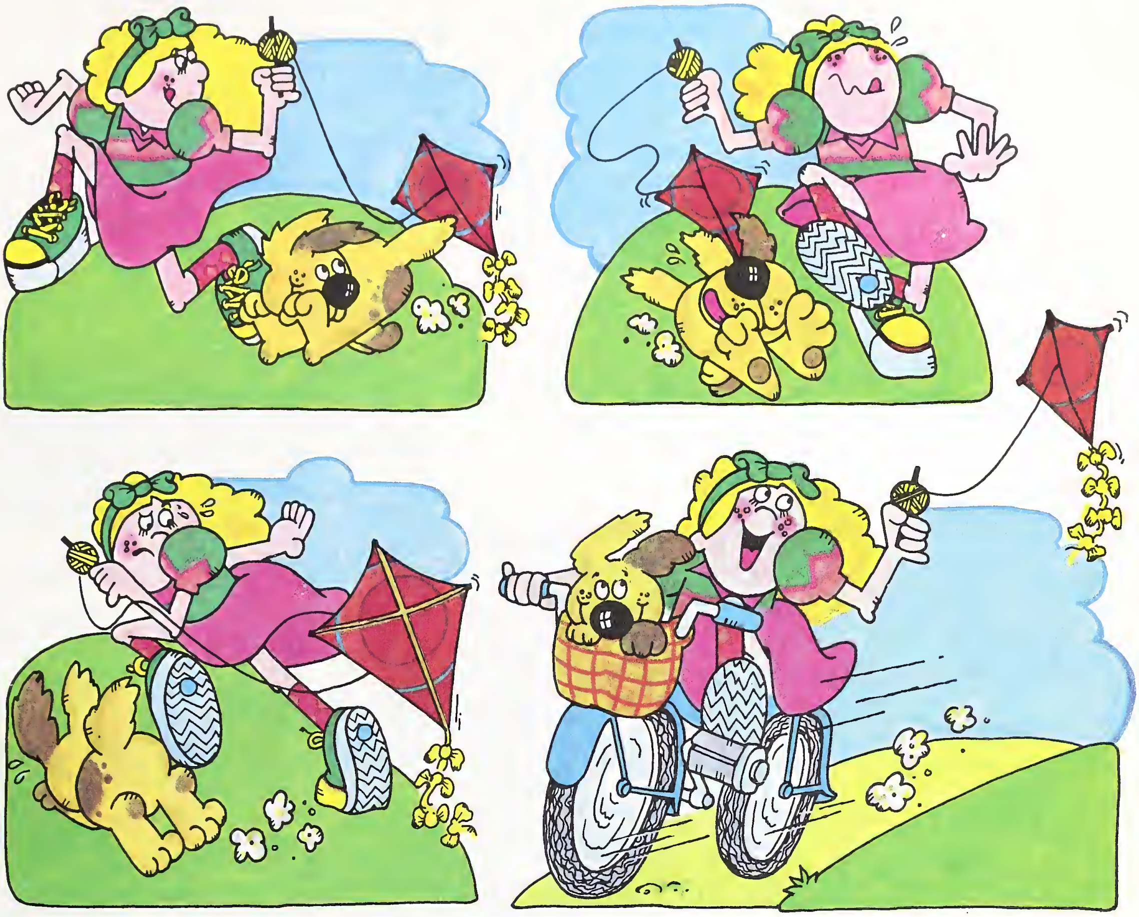
Answers for "What Animal Am I?": 1. A kangaroo rat. 2. A whale.

3 Work and Machines

1 **Work, work, and more work!**
2 **Simple machines**
3 **Teams of machines**
4 **Why work at all?**



Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see page T13 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit, and have the pupils begin collecting these materials. These activities are found on pages 101, 106, 111, 115, 119, 122, 124, 134, 136, and 138.



What was Amelia trying to do? [1]

How did she find an easier way? [2]

Have you ever found an easier or a faster
way to do something? If so, how did you do it?

Introducing the unit: You may wish to have the pupils look at the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:

[1] She was trying to run fast enough to get her kite in the air.

[2] She rode her bicycle.

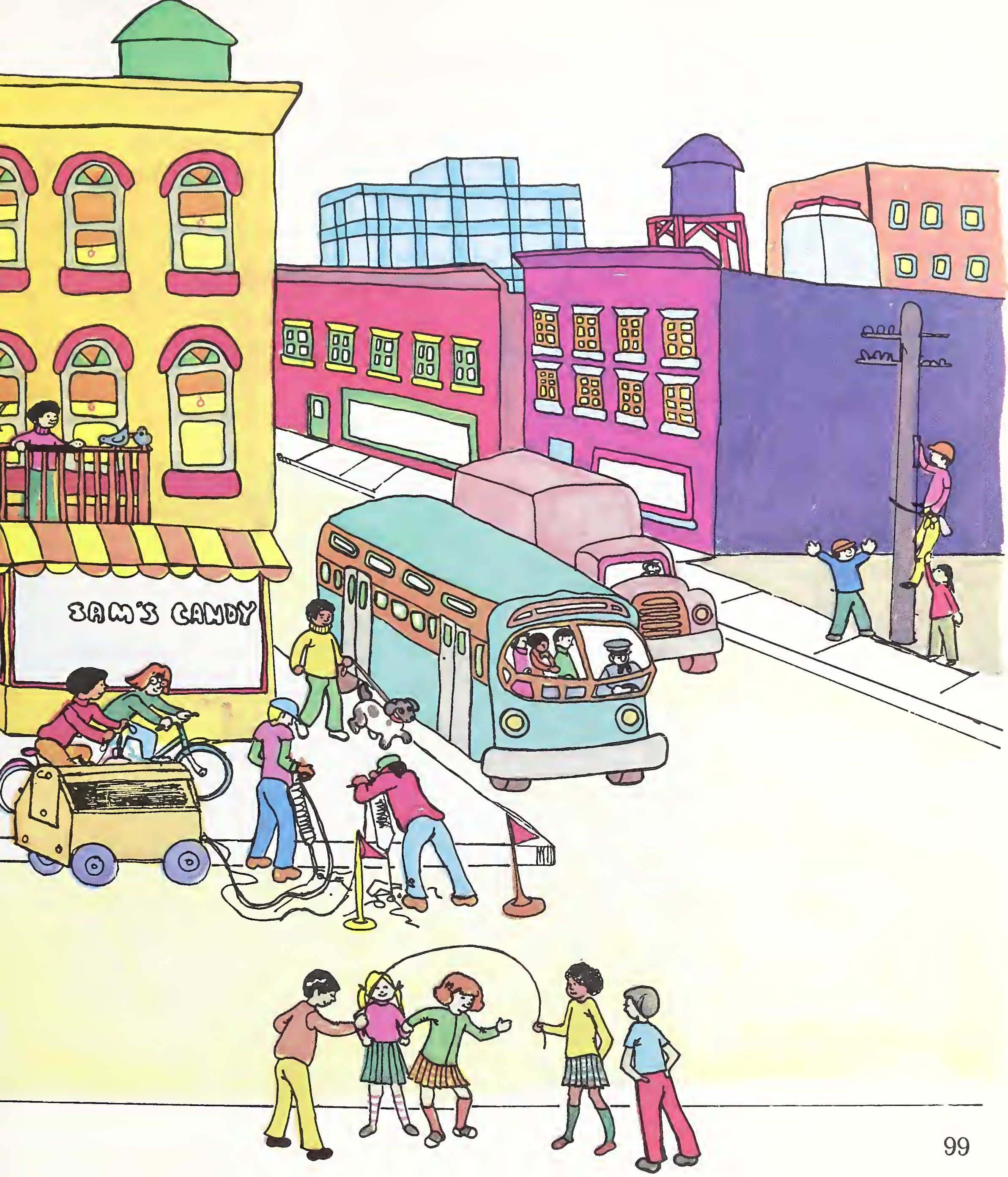
1 Work, work, and more work!

What does the word *work* mean to you? Does it mean lifting your book? Does it mean pushing a cart or pulling a sled? Doing these things may not seem like work. But whenever you move something, you are doing work. When have you seen people doing work? What were they moving? What work have you done today? What did you move?

Main concepts of the chapter (pages 98–103):
When you work, you use force to move something.
Lifting, pushing, and pulling are forces needed to move something.
The amount of work you do depends on the distance you move something.
Machines are used to help make work easier.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
- define work as using force to move an object through a distance;
- state that machines are used to help make work easier.

Important words: work, force, distance, machines.



Teaching helps for the picture above: After the pupils have read the introduction, have them look at the picture on pages 98 and 99 and point out all the people who are doing work. You might ask them what work is being done by each person.

For You to Think About

Every day you use force to move things. Sometimes you think of this as work. Other times you think of it as play. What work might you do when playing?

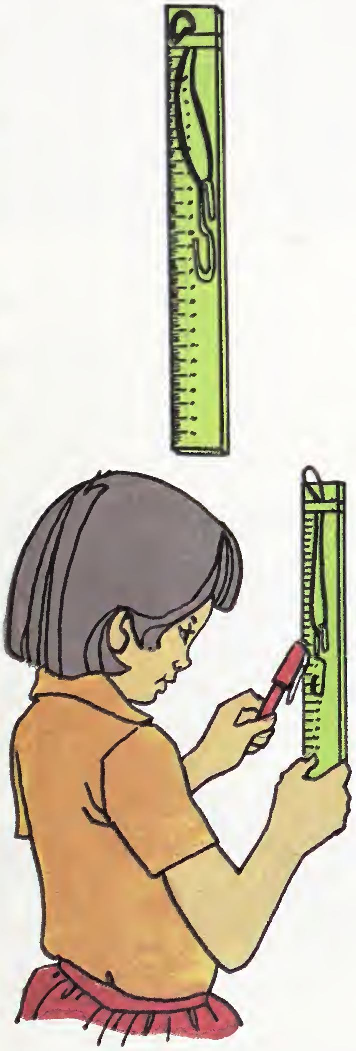
How strong?

As you may know, lifting a pencil is a lot less work than lifting a desk. This is because you use less *force*, or strength, to lift the pencil. Why do you think this is so? [1]

Much of the work you do each day needs little force. But some work you do needs a lot of force. What work have you done that needed a lot of force?

[1] **Sample answer:** The pencil has less weight than the desk.

Sample answer for "For You to Think About": Whenever something is moved during play, work is being done. Such things might be balls, bats, wagons, toy cars and trucks, dolls, game pieces, cards, darts, or jump ropes.



FINDING OUT

How can you compare the pulling force of objects?

You will need: ruler, rubber band, paper clip, tape, small objects such as keys or pens

- Tape one end of the rubber band to the end of the ruler as shown.
- Attach the paper clip to the free end of the rubber band as shown. You now have made a scale for measuring force.
- Hang an object from the paper clip.
- Write down how far the rubber band stretches along the ruler.
- Hang some other objects (one at a time) from the paper clip.
- Write down how far the rubber band stretches for each object.

Which object pulled on the rubber band with the most force? Why?
Do you think large objects will always stretch the rubber band more than small objects? Explain your answer.
When might you use a thin rubber band for comparing the pulling force of objects?
When might you use a thick rubber band for comparing the pulling force of objects?

Teaching helps for "Finding Out":
Processes used: observing, comparing, measuring, communicating, inferring, hypothesizing, interpreting data.
Sample findings: The heavier objects will pull on the rubber band farther than the lighter objects will. Large objects will stretch the rubber band farther than will small objects only if the objects are heavier. A thin rubber band can best be used for comparing very lightweight objects. A thick rubber band with less stretch can best be used for comparing heavy objects.
Additional information: Each of the pupils may report different amounts of force for the same object. This is because the size and strength of the rubber bands will vary. The pupils should compare the forces made only on their scale and not on those of others.

How far?

Imagine tying a rope around an elephant and trying to pull the elephant away. Pull and tug! You would most likely use a lot of force. But, would you do any work? Why or why not? [1]

Force is not the only thing that is important in doing work. The *distance*, or how far, something is moved is also important.

Suppose you pulled a friend in a wagon down your street. Now think about pulling your friend to the other side of town! You would use the same amount of force to keep the wagon moving during both trips. But you would do more work on the second trip. Why? [2]

For You to Think About

Suppose you and your friend were each asked to push five books across a table. You pushed all five at one time. Your friend went back and forth five times, pushing only one book at a time. Who would do more work? Why?

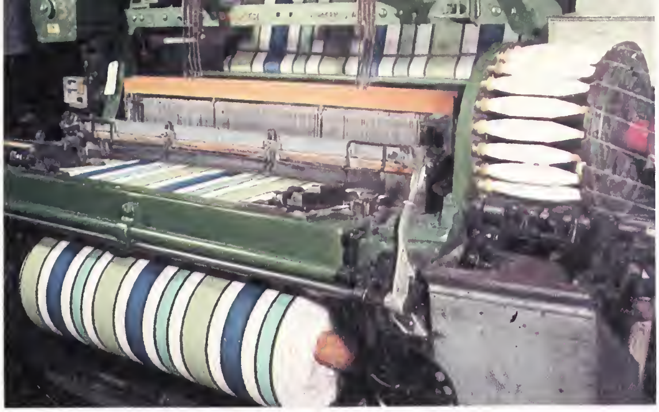
[1] **Sample answers:** No. Because the elephant would not have moved.

[2] **Sample answer:** Because the distance would be greater.

Who is doing more work in this picture? Why?

Sample answers for "For You to Think About": Neither. Both would be doing the same amount of work. Although going back and forth would take more time and energy, the same books would be moved the same distance.

Sample answers for the caption: Neither the boy nor the dog is doing any work. The boy and his dog are each pulling in opposite directions with the same force. Neither one is moving.



The machine in this picture is weaving cotton threads into cloth. The machine moves the different-colored threads to make a pattern in the cloth. Why do you think it is important for cloth to be made in this way?

How easy?

As you have learned, some work needs a lot of force. And some work is done over a long distance. Because of these things, work can be hard for people to do. So, people may use *machines*. Machines are things which help make work easier. In what ways do you think machines help make work easier?[1]

When people think of machines, they often think of cars or buses. But even a fork is a machine. You may be surprised, but there are machines all around you. What are some things around you that are machines?[2]

[1] **Sample answer:** Machines can either reduce the amount of force needed or the amount of distance covered.

[2] **Sample answer:** Doorknobs, window latches, knives, nails, parts of a desk.

A Second Look

1. What is work?
2. What is force?
3. Why do people use machines?

Sample answers for "A Second Look": 1. Work is moving an object through a distance. 2. Force is the strength needed to push, pull, or lift something. 3. Machines help make work easier.

Sample answer for the caption: It would take years for people to make the cloth that the machine can make in a few minutes.

2 Simple machines

People have been using machines for many years. Machines were first used for doing simple work like lifting and carrying water. Later, people used machines to make things like clothes. In fact, people learned to use machines for making other machines!

Do you think people will always use machines? Why or why not?[1]

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[1] **Sample answers:** Yes. Because people will always want to make work easy.

Main concepts of the chapter (pages 104–125):
Simple machines can help people do work.
There are six simple machines. They are the inclined plane, the wedge, the screw, the lever, the wheel and axle, and the pulley.

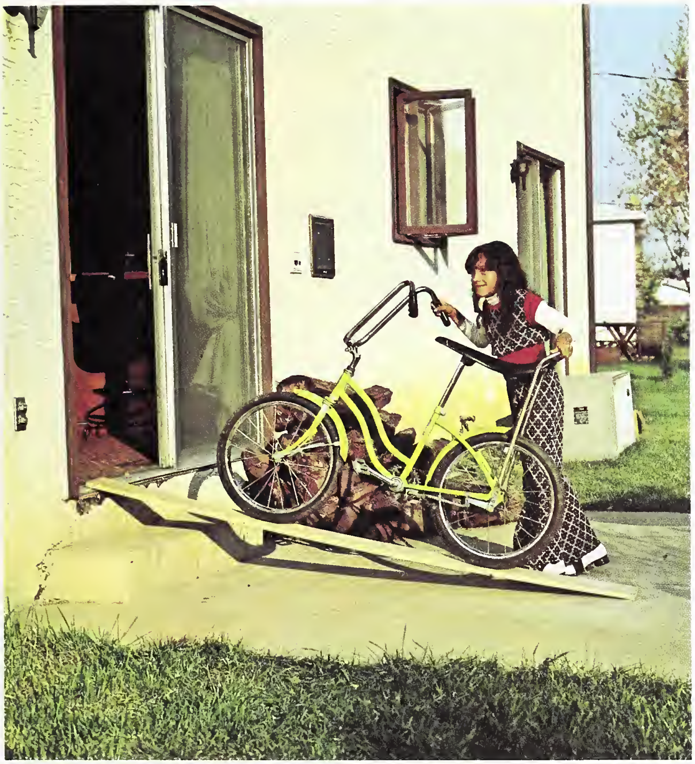
Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—name at least four simple machines;
—demonstrate the use of each of these simple machines;
—explain how each of these simple machines makes work easier.

Important words: inclined plane, wedge, screw, lever, wheel and axle, pulley, load arm, force arm, fulcrum, gear.

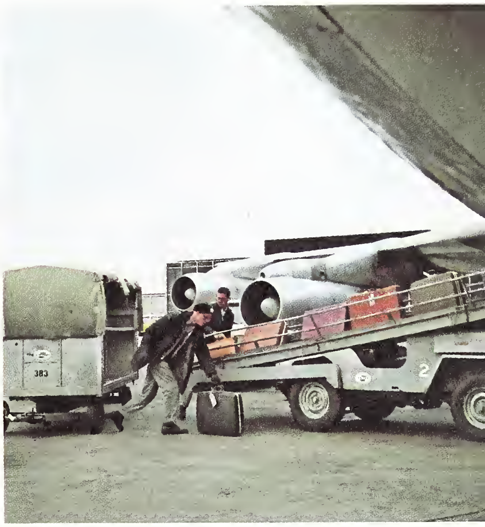
Inclined planes

Today there are hundreds of different machines. But no matter what machines people may use, all machines are made up of just a few kinds of *simple machines.*

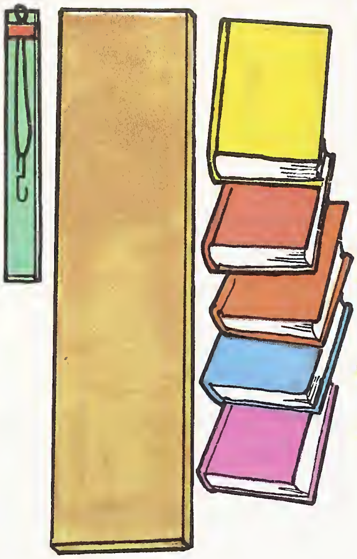
One kind of simple machine is the *inclined plane.* Inclined planes let you use less force when you move something. The pictures on this page show how inclined planes help people do work.



These pictures show two ways in which inclined planes are used. How is the inclined plane helping the men do work? How is the inclined plane helping the girl do work?



Sample answers for the caption: The girl's use of an inclined plane helps her use less force because she does not have to lift her bicycle above the steps. The moving inclined plane moves the baggage up to the plane.



FINDING OUT

How does an inclined plane help you do work?

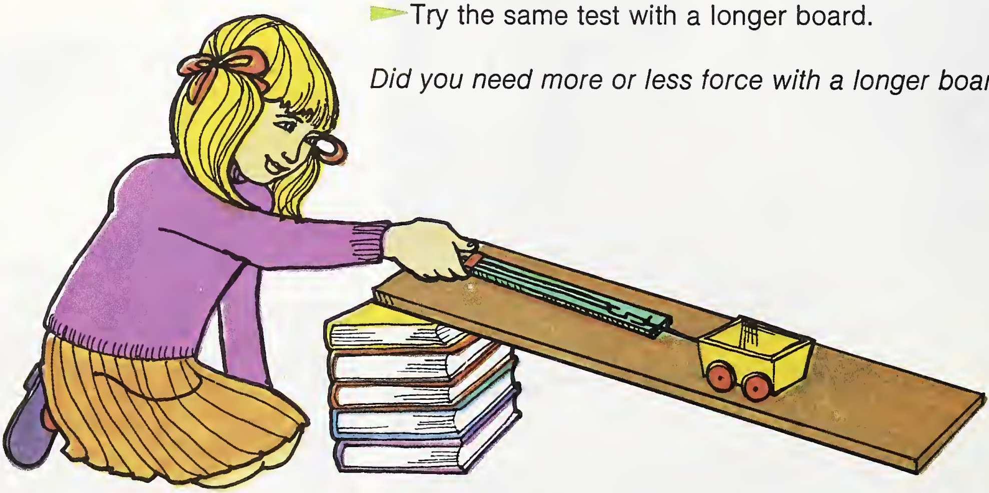
You will need: board, about 5 books, small toy cart or toy car, spring scale (A spring scale can be made with a ruler, a rubber band, and paper clips as shown.)

- Connect the cart to the spring scale.
- Use the spring scale to lift the cart. See how much force is needed. This is shown by how much the spring scale stretches.
- Make an inclined plane with the books and board as shown.
- Use the spring scale to pull the cart up the inclined plane. See how much force is needed.

Which time was less force needed? Why was less force needed?

- Try the same test with a longer board.

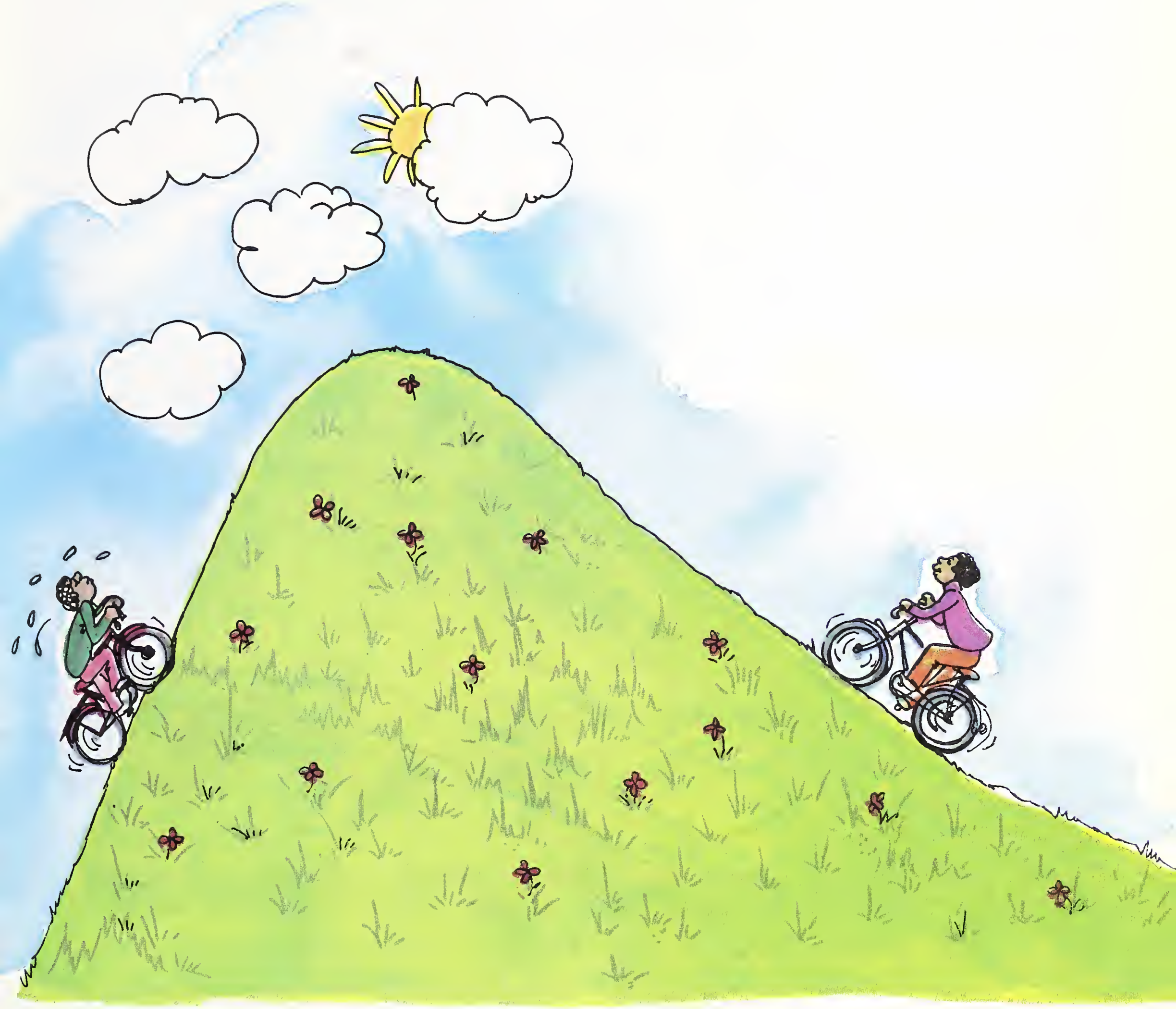
Did you need more or less force with a longer board?



Teaching helps for "Finding Out":
Processes used: observing, measuring, comparing, inferring.
Sample findings: Depending on the strength of the rubber band, the force needed to lift the cart will most likely be great. It is quite possible that many carts will cause the rubber band to stretch the length of the ruler. Pulling the cart up the inclined plane will reduce the amount of force. The longer board will increase the distance, thus decreasing the force.
Additional information: The number of books used will determine the height of the inclined plane. When fewer books are used, the angle of the inclined plane and the force will be less.

There are many kinds of inclined planes. One kind is a staircase. A hill is also a kind of inclined plane. Look at the drawing below. Which rider is using less force to get up the hill? Why?[1]

[1] **Sample answers:** The rider on the right. He is on the longer inclined plane.



Teaching helps for the picture above: After the pupils have studied the picture and answered the questions on this page, you might ask this question: Who is doing more work? Although the boy on the right needs less force to get to the top, he must travel a greater distance. The two are doing the same amount of work. The work is getting their bike to the top of the hill, no matter how steep or long the hill is.

Wedges

Have you ever pushed a tack into a board? If so, you may know that the point on the tack helps you get it into the board. Imagine pushing a tack with no point. Do you think you would use more force? Why or why not?[1]

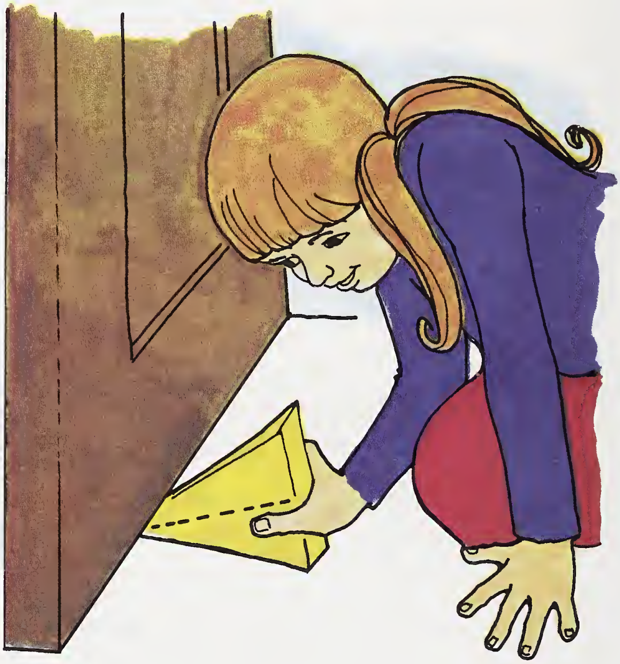
The point on a tack is a simple machine. It is called a *wedge* [WEHJ]. Wedges are used to push things apart. They may also be used to cut things. A knife is another kind of wedge. Which part of the knife cuts? Using a sharp knife can help make work easier than using a dull one. Why do you think this is so?[2]

For You to Think About

The bow, or front, of most boats is shaped like a wedge. Why do you think most boats are shaped this way?

[1] **Sample answers:** Yes. Because a tack without a point could not push the board open for the rest of the tack to go through.

[2] **Sample answer:** A sharp knife is able to cut through and separate what is being cut with less force.

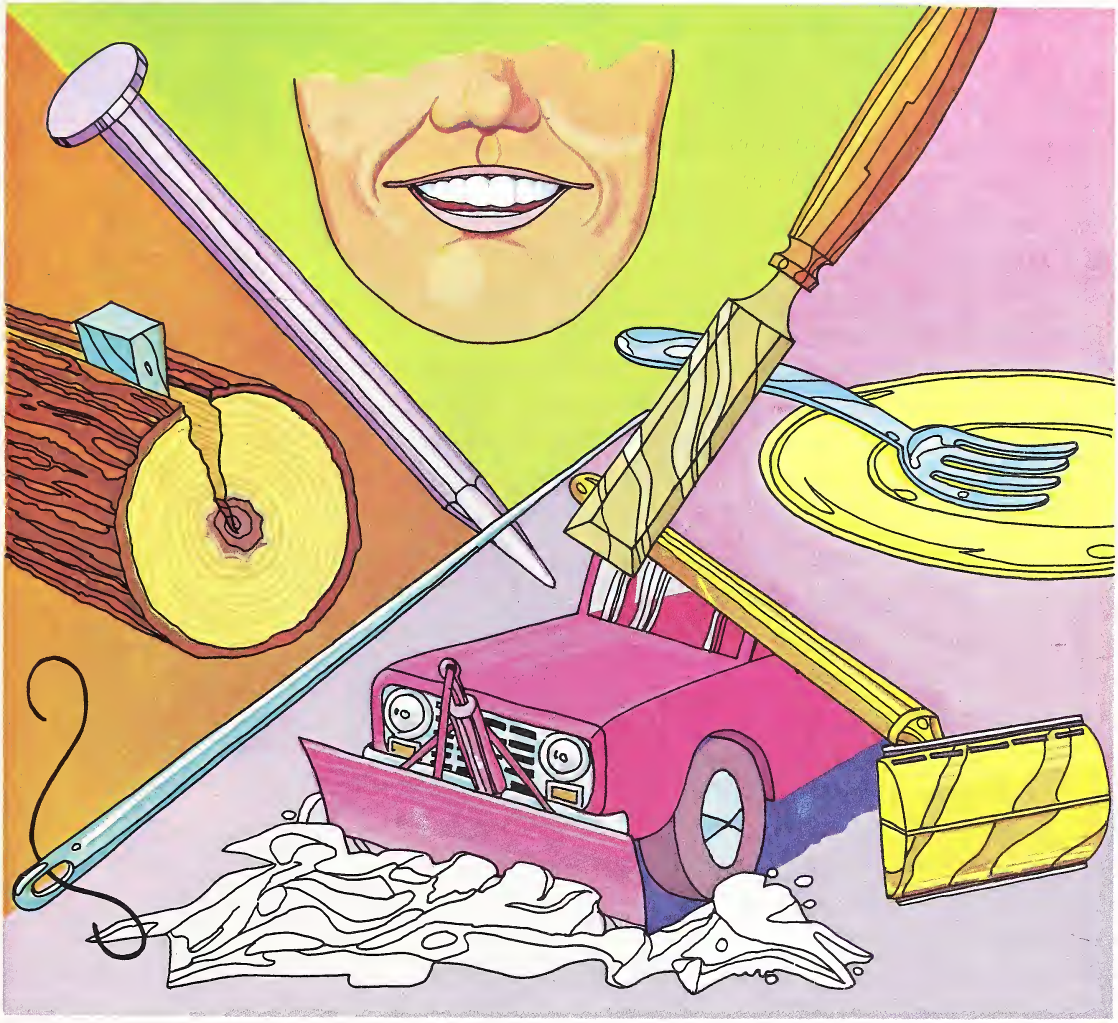


Point out the wedge in this picture. How is it being used? How is a wedge like an inclined plane?

Sample answer for "For You to Think About": The bow of a boat can cut through the water in much the same way a wedge can cut through wood. The sharper and longer wedge can push through more easily than any flat surface.

Sample answers for the caption: The wedge is being used as a stop to keep the door open. The dotted line shows the division of two inclined planes joined together to make a wedge.

There are many other kinds of wedges. Some of them are pictured on this page. How can each one help people do work?[1]



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[1] **Sample answer:** The wedge on the point of the nail makes hammering easier. The teeth can chew food with less force. The chisel can scrape paint with less force. The fork can pick up food with less force. The razor blade can cut hair with less force. The blade on a snowplow can push snow with less force. The needle can push through material with less force. The wedge can split the log with less force.

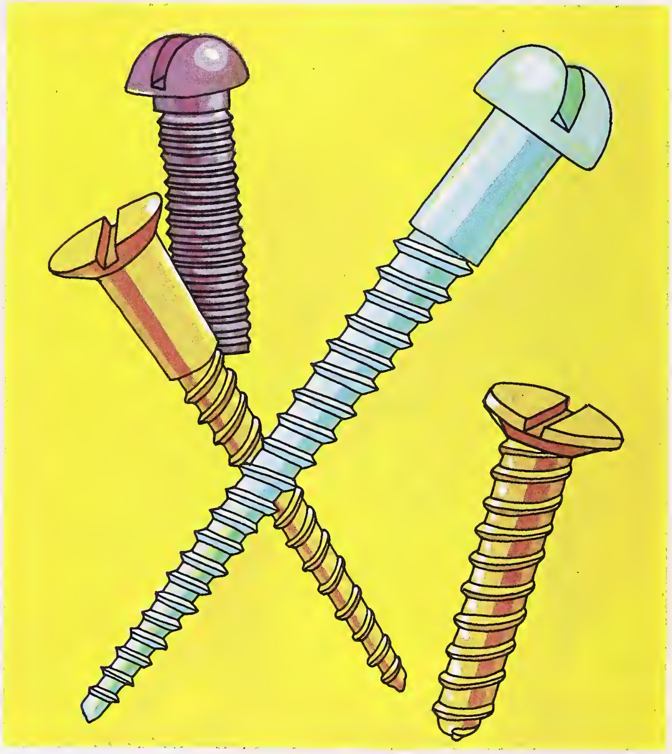
Screws

Have you ever used a jar with a top you had to twist on and off? If so, you were using another simple machine. The part of the top that holds it to the jar is a simple machine called a *screw*.

Besides jar tops, there are other kinds of screws used to hold things together. Look at a door. Screws hold the door to the wall. The handle or knob is held on by screws. What are some other things held together by screws?[1]

Exploring on Your Own

There are many different kinds of screws used by builders. Some screws are long and thin. Others are short and fat. Find out what other kinds of screws are used. Also find out the times when some kinds of screws are used instead of others. To do this, you might ask a carpenter or builder or visit a hardware store.



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[1] **Sample answer:** Desks, chairs, windows, bicycles.

Sample findings for "Exploring on Your Own": The length of the screw depends on how deep the screw must be inserted. The number of times the thread goes around the screw depends on how securely two things are to be held together. A screw with many thread turns takes longer to get into wood but will hold more securely. It is also easier to turn a screw with more threads because there is a greater distance. A screw with fewer turns of a thread takes more force to put into wood. The type of screw that is used also depends on the type of material through which it is turned.

FINDING OUT

Which would you use, a screw or a nail?

You will need: 4 small pieces of wood, wood screw, screwdriver, nail, hammer

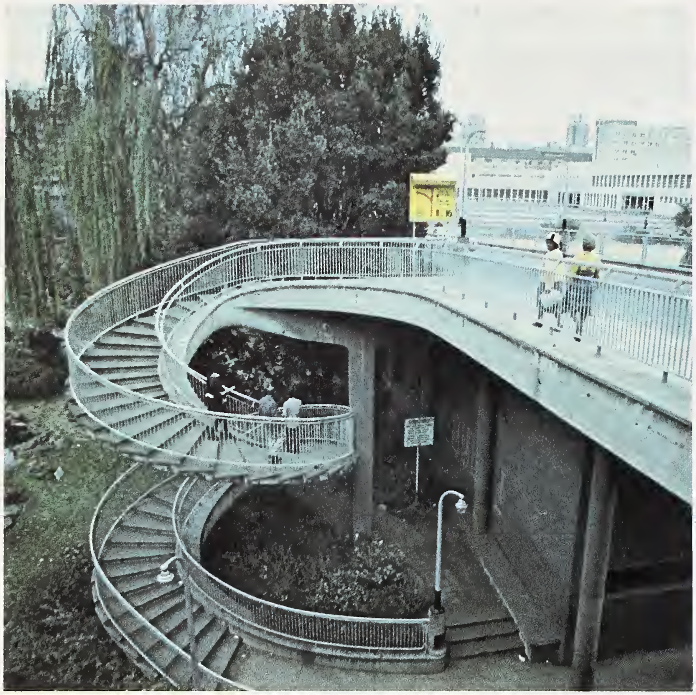
- Hammer 2 pieces of wood together.
- Screw 2 pieces of wood together.

Which took longer to put in, the screw or the nail?

- Try to pull the pieces of wood apart. Use the screwdriver as a wedge.

Which holds better, the screw or the nail?
When might a person wish to use a nail instead of a screw? Why?
When might a person wish to use a screw instead of a nail? Why?

Teaching helps for "Finding Out":
Processes used: comparing, inferring, interpreting data.
Sample findings: The screw will take longer to get through the pieces of wood because the number of turns will increase the distance the screw must move. Using the screwdriver as a wedge, the pupils will find it easier to separate the boards held together with the nail. A nail would be used instead of a screw when a person wanted to hold things in place, but not as securely as a screw would hold them. A screw would be used instead of a nail when a person wanted things held more securely in place.



The stairway (above left) is a kind of screw. In what ways is it like other kinds of screws? Why do you think this kind of stairway is used?

Screws can also be used to lift things. The seats of some chairs have screws. When the seat is turned, it may go up. The second picture on this page shows a screw being used to lift a platform. What other things might be lifted by using a screw? 1

Another way in which screws are used is to push or pull things. Propellers on boats are screws which push against the water. How does this help a boat move? 2 Propellers on airplanes are also screws. How do you think a propeller helps a plane move? 3

[1] **Sample answer:** A wall, a roof, a car.

[2] **Sample answer:** By pushing the water behind the boat, a propeller can push the boat forward.

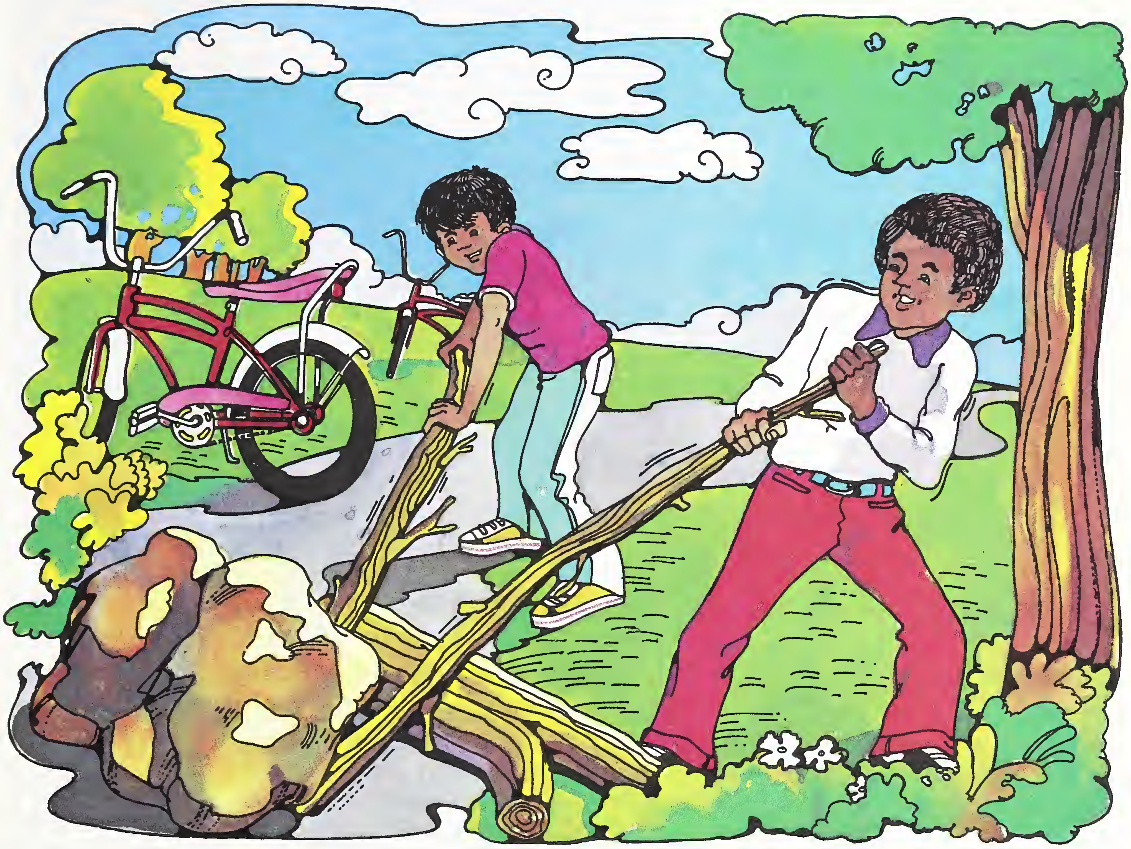
[3] **Sample answer:** A propeller can push air behind the plane to force the plane forward.

Sample answers for the caption: The stairs are like a screw in that they twist around in a circle and go up and down. Circular stairs are not as steep as stairs that are straight.

Levers

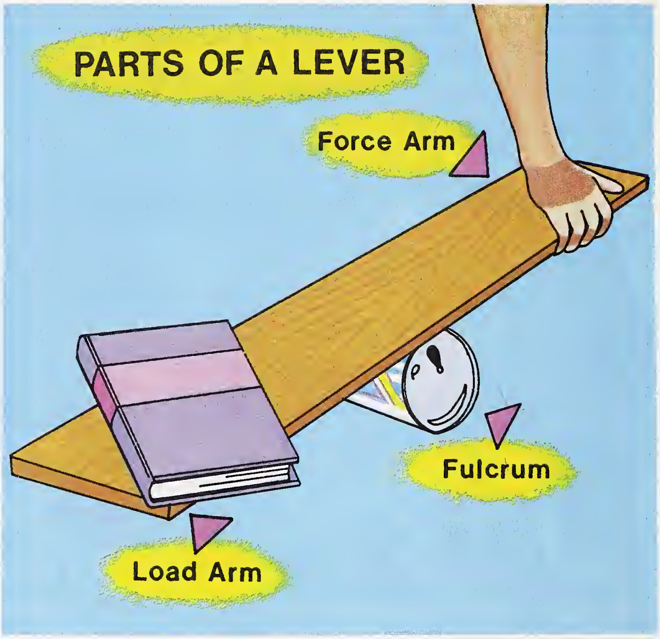
Imagine trying to lift a desk without even touching it. Do you think you can do it? You can, if you use a *lever*. A lever is another kind of simple machine. The picture on this page shows how a lever works. How are these levers helping these children do work? [1]

[1] **Sample answer:** The rock is too heavy to lift without using a machine. These boys can push their stick (lever) down and can make the rock lift up and out of the way.



Suggested activity: After the pupils have read the text and studied the picture on this page, you might have them draw the results of this scene. You might ask them to show how the stick levers are used and what happens to the rock.

When using a lever, it is often helpful to think of it as having three parts. The drawing below shows these parts.



In the center of this lever is the *fulcrum*. The fulcrum is the point on which the lever rests. On both sides of the fulcrum, there is an "arm." One arm has the load, or what you want to move. It is called the *load arm*. The other arm is the arm you force down. It is called the *force arm*. Think about playing on a seesaw. Where is the fulcrum? Where is the force arm? Where is the load arm?[1]

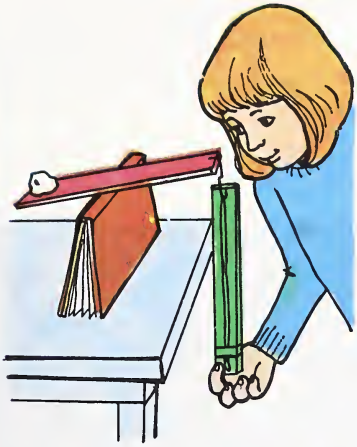
[1] **Sample answers:** The fulcrum is the bar in the middle that holds the board. The arm that is in the air is the force arm. As it pushes down, the load arm on the ground is pushed up.

Suggested activity: After reading about the parts of a lever on this page, the pupils might make levers of their own. A simple lever could be a ruler on top of an eraser. Any board or long stick in the classroom can be made into a lever. A fulcrum can be the edge of a desk or a small triangle made from cardboard. Have your pupils try moving things with their lever.

FINDING OUT

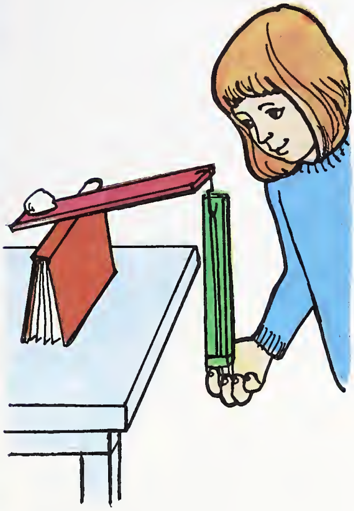
Does moving the fulcrum make a difference?

You will need: spring scale, board or ruler, thin book, small flat rock or other flat object



- Lift the rock with the spring scale. Read the force needed to lift the rock.
- Set up a lever with the book as a fulcrum in the middle as shown.
- Place the rock on one end of the lever.
- With the spring scale, pull down on the lever as shown. Read the force needed.

Was less force needed to lift the rock this time?



- Move the fulcrum closer to the spring scale.
- Pull down and read the force.
- Move the fulcrum closer to the rock. Pull down and read the force.

Where was the fulcrum when the most force was needed?
Where was the fulcrum when the least force was needed?

- Try the same test with a longer board.

Does a longer board help make the work easier? Why or why not?

Teaching helps for "Finding Out":
Processes used: observing, measuring, comparing, inferring.
Sample findings: When the load is near the fulcrum, less force is needed to lift the load than when the load is far from the fulcrum. A long board can make work easier if the load is near the fulcrum. However, if the load is far from the fulcrum, more force will be needed to lift the load.

[1] **Sample answer:** The wheel is the fulcrum.

[2] **Sample answer:** The force is at the handles. The pile of leaves in the container is the load.

There are different kinds of levers. Some levers, like the seesaw, have the fulcrum in between the force and the load. Some other levers have the load in between the force and the fulcrum. A wheelbarrow works like this. Where is the fulcrum on a wheelbarrow?[1] Where are the force and the load? [2]

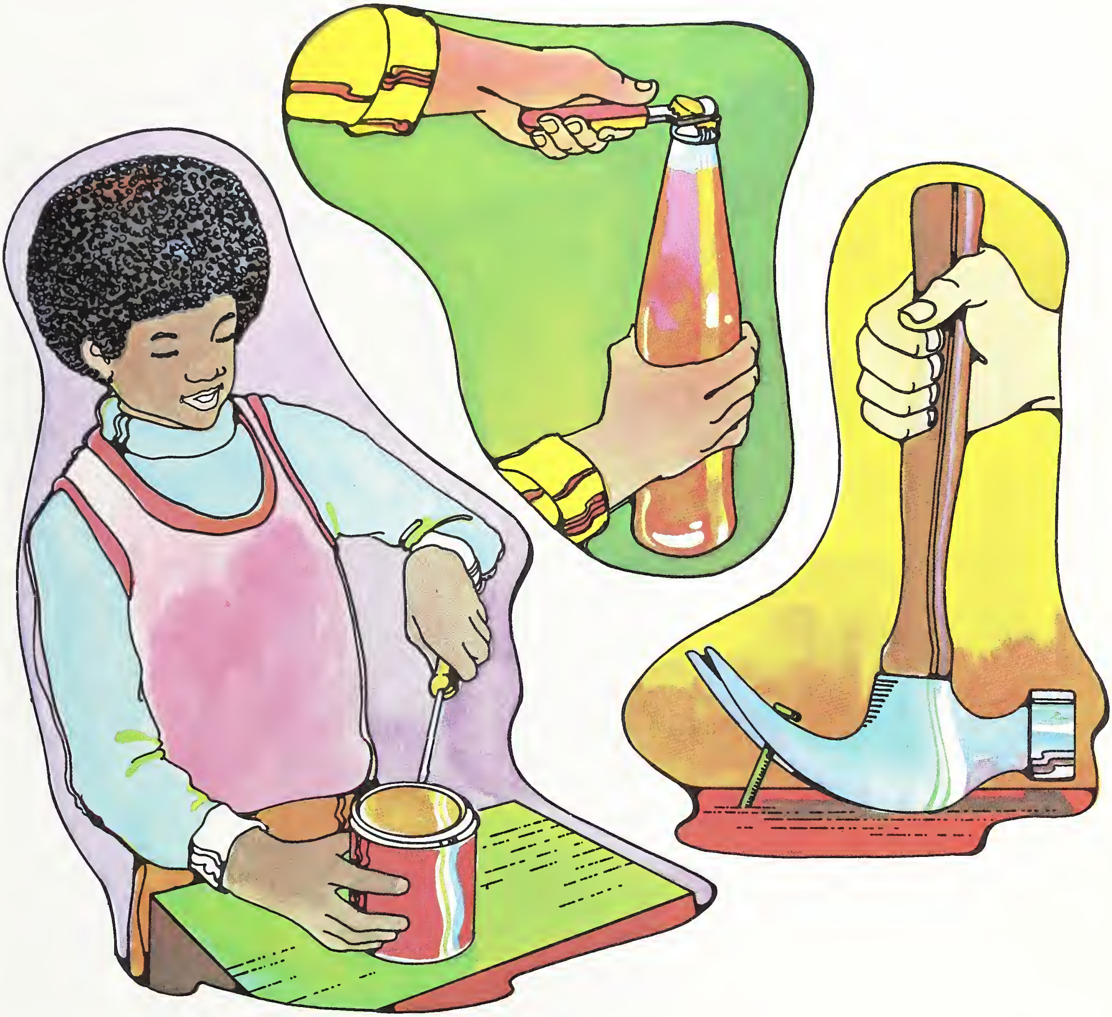
[3] **Sample answers:** The force is in your fingers that push in the middle. The fulcrum is where the two ends join together. The load is what is being picked up at the ends of the tweezers.

Another kind of lever has the force in between the fulcrum and the load. Tweezers work like this. When you pick up something with tweezers, where is the force? Where is the fulcrum? Where is the load? [3]

Suggested activity: After the pupils have read about the different kinds of levers on this page, you might encourage them to find examples of these different kinds of levers. You might suggest to them that they look in a kitchen, as there are different cooking utensils which are levers.

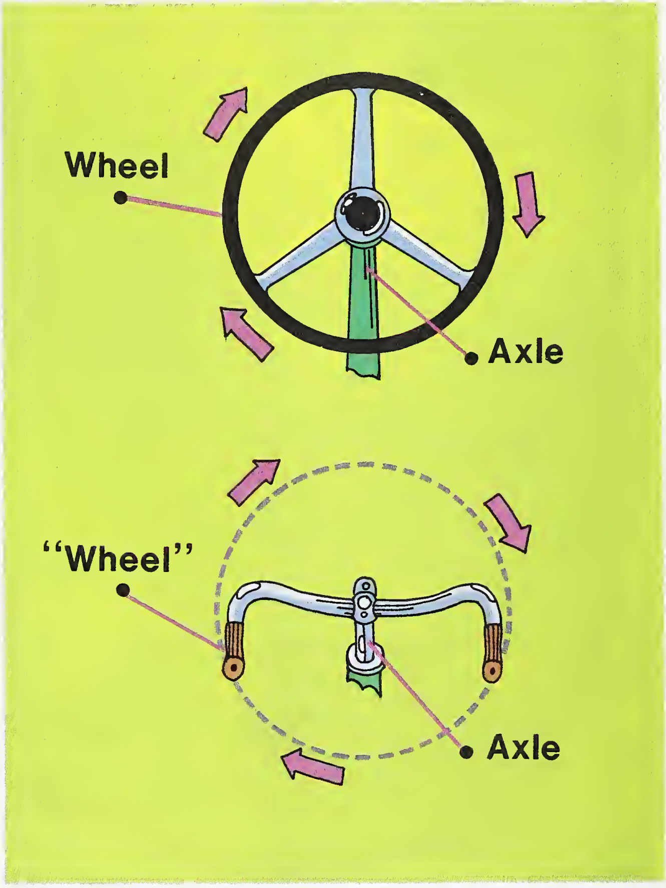
The pictures on this page show some levers in use. What work is being done with each lever?[1] What work have you done with a lever?

[1] **Sample answer:** A bottle cap is being lifted off a bottle. A nail is being pulled out of wood. A paint lid is being lifted off a paint can.



Wheel and axle

Another simple machine is the *wheel and axle* [AK-suhl]. This machine is made up of a wheel and a rod. The rod is the axle. It is joined to the center of the wheel. The picture below shows two kinds of wheel and axle machines. How are they alike?[1]



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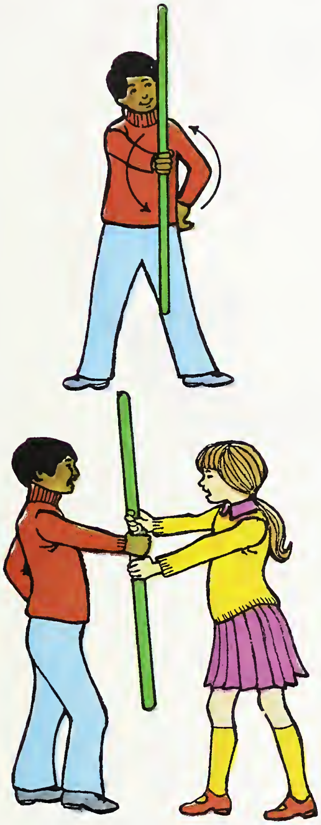
[1] **Sample answer:** The handlebars on a bicycle turn in a circle the same as the wheel of a car. Each can be turned in either direction on its own axle.

Suggested activity: After the pupils have read about the parts of a wheel and axle machine on this page, you might have them make one. A pencil that is firmly stuck in a round piece of cardboard is an easy wheel and axle to make. Be sure to remind the pupils that the wheel and axle cannot turn separately. Have the pupils try finding out what work they can do with their wheel and axle machine.

A doorknob is also a kind of wheel and axle. Think about opening a door. As you turn the knob, the axle turns and opens the door. Try opening a door by turning just the axle. How does a knob help you turn the axle?[1]

[1] **Sample answer:** The knob is the wheel. By turning the wheel, the knob can turn the axle which is much smaller. Large doorknobs make it easier to open doors than small doorknobs.



FINDING OUT

Which is better, a large wheel or a small wheel?

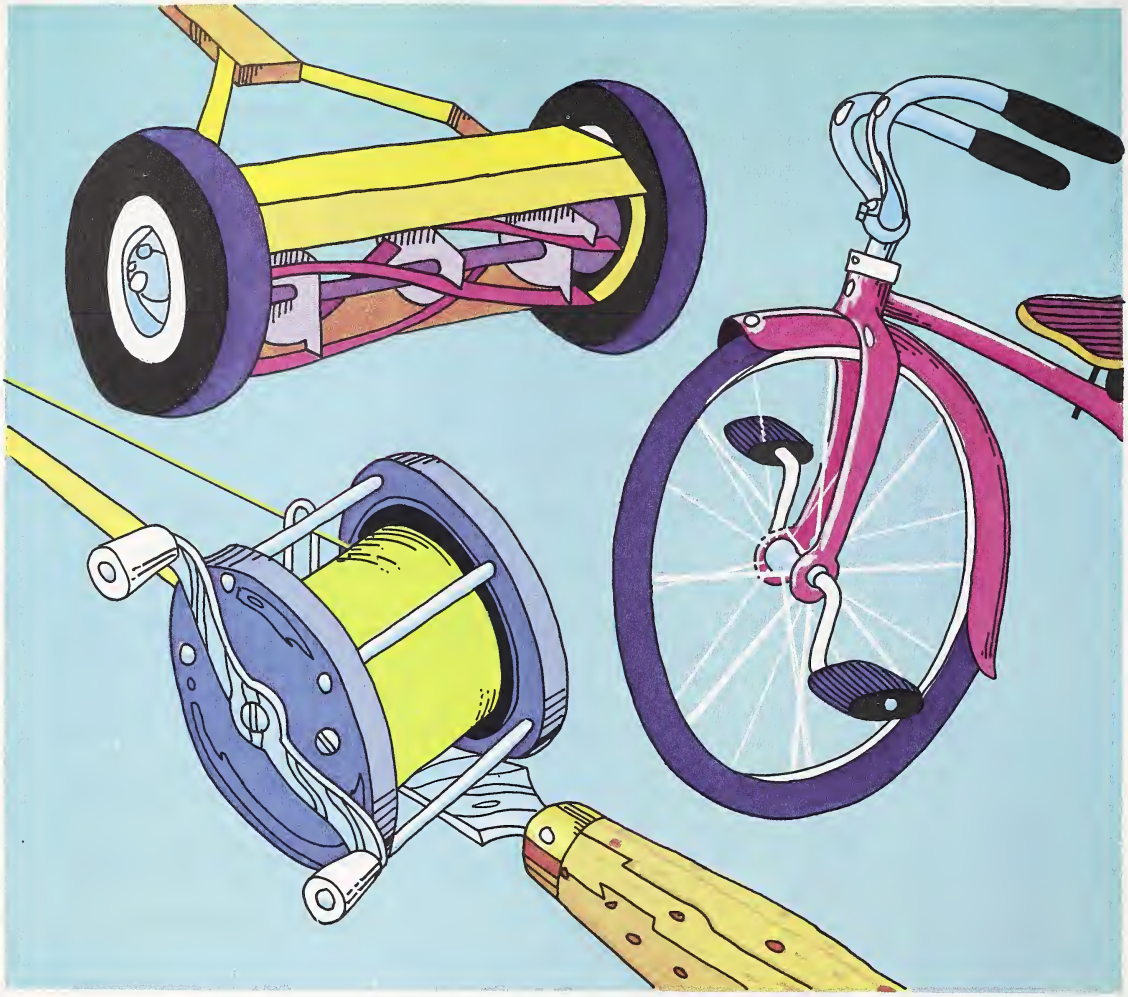
You will need: broomstick or other long stick

- With one hand, hold the stick in the middle and turn it as shown. (Your arm can be thought of as an axle. The stick works like a wheel.)
- Have a partner grab the "wheel" with both hands right next to your hand as shown.
- Try to keep the "wheel" from turning while your partner tries to turn it.
- Now have your partner grab the "wheel" farther away from your hand.
- Try to keep the "wheel" from turning while your partner tries to turn it.
- Change with your partner, and do the test again.

Which way is easier to turn the "wheel"?
How do you think a large wheel on a wheel and axle helps make work easier than a small wheel?

Teaching helps for "Finding Out":
Processes used: comparing, observing, interpreting data.
Sample findings: It is easier to turn the wheel when the force is farther from the axle than when the force is closer to the axle. Using a large wheel means turning it over a greater distance, but less force is needed.

Extending the "Finding Out": After the pupils have completed the activity, you might have them find out about the different-sized steering wheels used to drive different things such as boats, trucks, race cars, and buses that do not have power steering. The wheel sizes are made according to the force needed to make turns.



The pictures on this page show some other kinds of wheel and axle machines. Point out the wheel and axle in each picture. How does each wheel and axle help make work easier?[1]

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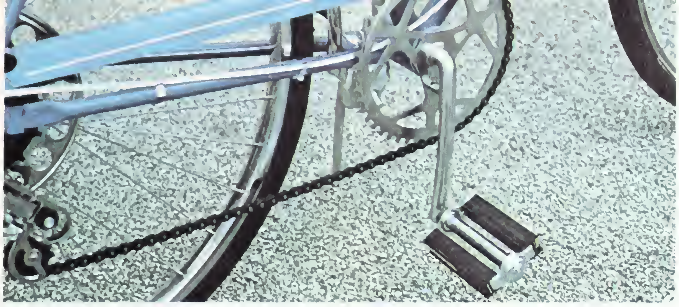
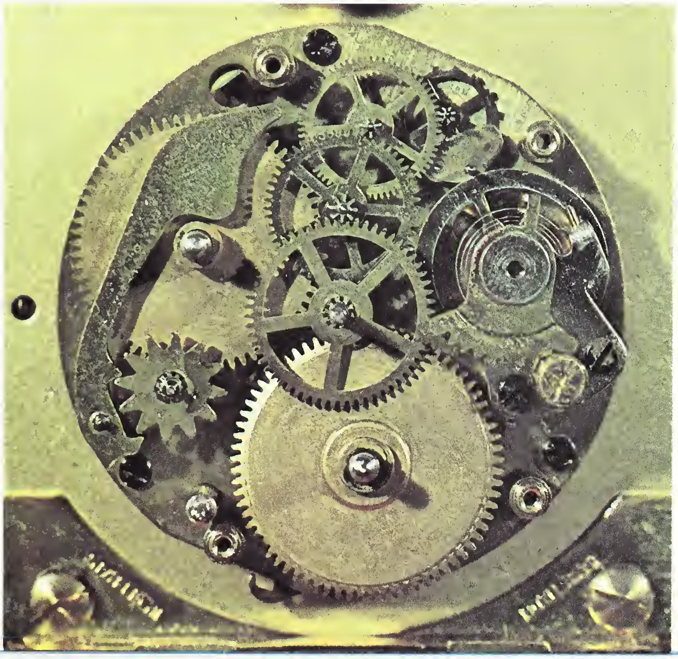
[1] **Sample answer:** The lawn mower has large wheels which, when they are turned, make the blades turn. The blades are attached to the axle. This makes work easier because less force is needed to push the blades. The pedals on the tricycle are the wheel. As they are pushed in a circle, the axle of the wheel turns. This makes work easier because the distance the wheel turns becomes greater. The crank on the rod is the wheel which, when turned, will move the fishing line around the axle. This makes work easier because less force is needed to wind up the fishing line.



Sometimes the wheel on a wheel and axle has teeth. This kind of wheel is called a *gear*. Look at the picture of the bicycle on this page. How does the gear help turn the wheels? [1]

A gear can also turn another gear. Gears are used this way inside of watches. The hour hand has a gear. The minute hand has a gear. Why do you think the minute hand turns faster than the hour hand? [2]



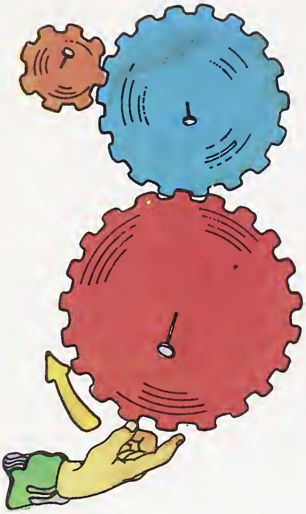
Exploring on Your Own

Some bicycles have more than one gear. Racing bicycles may even have ten gears. Find out how gears help you in riding a bicycle. To do this, you might visit a bicycle shop or use a reference book. Look under the headings *bicycles* and *gears*.

[1] **Sample answer:** The chain of the bicycle fits into the teeth of the gear. As the gear turns during pedaling, the chain also turns. The chain is attached to the back wheel, which will turn the gear and wheel.

[2] **Sample answer:** The gear for the minute hand is much smaller than the gear for the hour hand.

Sample findings for "Exploring on Your Own": The different gears on a bicycle range in size. Each size gear has a different number of teeth. The large gears make pedaling easier than the small gears. However, pedaling with the small gears makes the bike go faster than pedaling with the large gears.



FINDING OUT

How do gears make other gears turn?

You will need: cardboard, scissors, pins or nails

- Make 2, 3, or more different-sized gears as shown.
- Set up your gears so that the teeth fit into one another as shown.
- Turn the largest gear clockwise.

Do the smaller gears turn faster or slower than the large gear? Why?
When you turn the largest gear clockwise, which way do each of the other gears turn?
How might you set up a gear to turn a wheel? Try it.

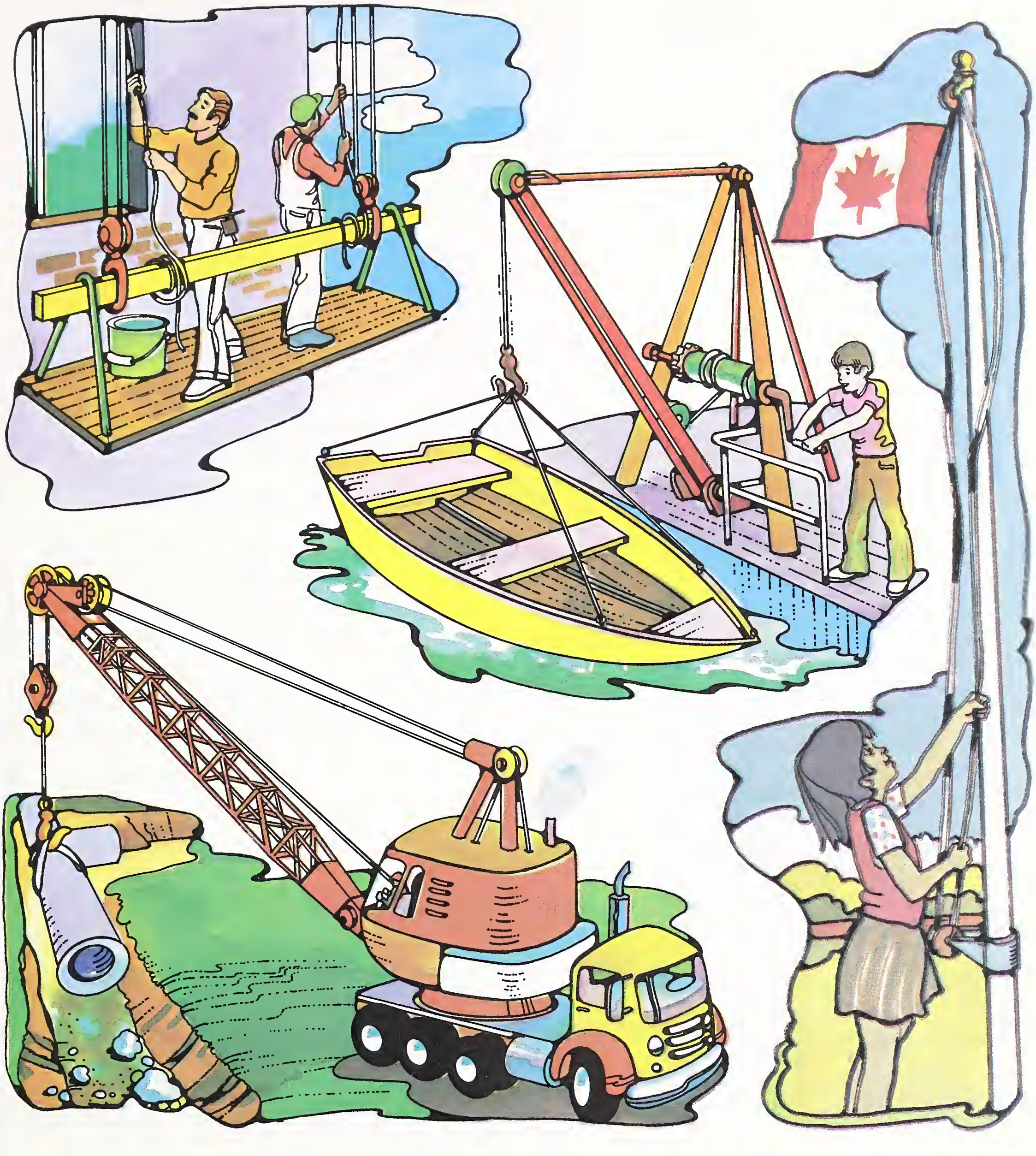
Pulleys

As you may know, when you use a lever, you use force in one direction. The load moves in another direction. Another simple machine works in this way. It is a *pulley* [PUL-ee]. A pulley is made up of a wheel and a rope.

When you use a pulley, you use force in one direction. The load then moves in another direction. Look at the pictures on the next page to see how a pulley works. In which direction are the forces used? In which direction are the loads moved?[1]

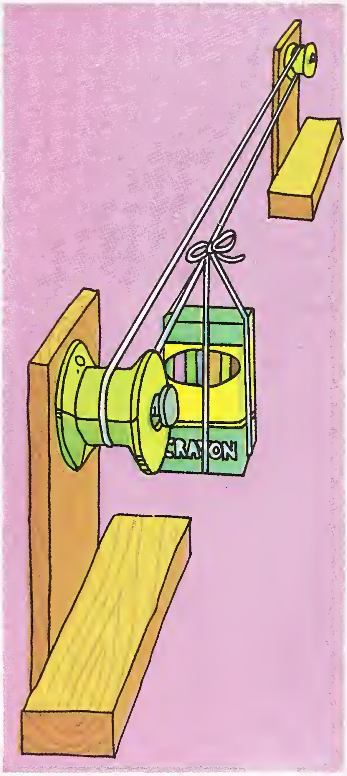
[1] **Sample answers:** The window washers are pulling down on the ropes in order to lift their platform. The boy is cranking the rope toward him in order to lift the boat. The girl is pulling down on the rope in order to raise the flag. The wire cord is being cranked into the truck in order to raise the pipe.

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring, experimenting.
Sample findings: When the large gear is turned once, the small gears may turn one and a half times or twice in the same time. This happens because there are fewer teeth in the small gears. If the large gear has twenty teeth and the small has ten, then the small gear will turn twice as fast. When the large gear is turned clockwise, the gear next to it will turn counterclockwise. If a string is wrapped around the axle of a gear and wheel, the turn of the gear will make the wheel turn.



Many times it is hard to get at something to move it. For this reason, you might want to use a pulley. Pulleys can help raise flags on high poles. They can help lift things out of water. When else might a pulley be used?[1]

[1] **Sample answer:** Tow truck lifting a car, movers hoisting loads to a high platform, boat lowering divers into an ocean.



FINDING OUT

How can you move things with a pulley?

You will need: 2 thread spools, string, nails, boards, hammer, small objects for "loads"

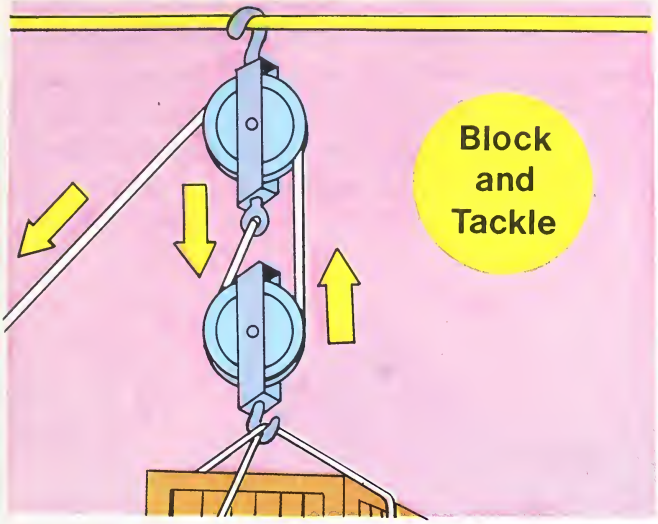
- Attach each spool to a board as shown. (These are your pulleys.)
- Place 2 pulleys on opposite sides of the room.
- Tie a string around the pulleys. Attach a load to the string.

How might you use your pulleys to get a load from the other side of the room?

- Try it. If a load is too heavy, try using 2 strings together.

How might you use your pulleys to get a load from the floor to the ceiling? Try it.
How might you use your pulleys to get a load from a high place to a low place? Try it.

Teaching helps for "Finding Out":
Processes used: observing, experimenting.
Sample findings: By pulling on the string, the pupils can turn the string around the pulleys and move the attached load to the other side of the room. If a pulley can be attached to the ceiling (or more practically to the top of a door), a load can be moved up and down.



These pulleys joined together as shown here are known as a block and tackle. Each additional pulley makes it easier to move something. Why?

Most often, a pulley by itself cannot help you use less force to move something. But two pulleys can. Three, four, or even more pulleys can be used together to help make work still easier. When have you seen pulleys being used? What work was being done?

A Second Look

1. What are the names of some of the six simple machines?
2. How does using an inclined plane or a screw help make work easier?
3. How does using a lever or a pulley help make work easier?

Sample answers for "A Second Look": 1. Inclined plane, wedge, screw, lever, wheel and axle, pulley. 2. Using an inclined plane or a screw can help make work easier because each can reduce the amount of force needed. 3. A lever can reduce the amount of force needed to move an object. A pulley can move something in the opposite direction.

Sample answer for the caption: Each additional pulley needs a longer rope. Because the distance is increased, the force is decreased.

3 Teams of machines

As you may have read earlier, all machines are made up of simple machines. In fact, most machines you see and use every day are made up of two or more simple machines. These machines are called *compound machines.*

What might a person cut best by using scissors which have short blades and long handles? Why? What might a person cut best by using scissors which have long blades and short handles? Why?

Isn't that simple?

One compound machine that you probably use is a pair of scissors. Scissors may seem simple. But one pair is made up of two levers. They are joined at the fulcrum. On each lever there is also a wedge used for cutting. Some scissors are pictured on this page. Point out the levers, the fulcrum, and the wedges.

Main concepts of the chapter (pages 126–131):

Compound machines are made up of two or more simple machines.

There are many ways in which compound machines are used.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

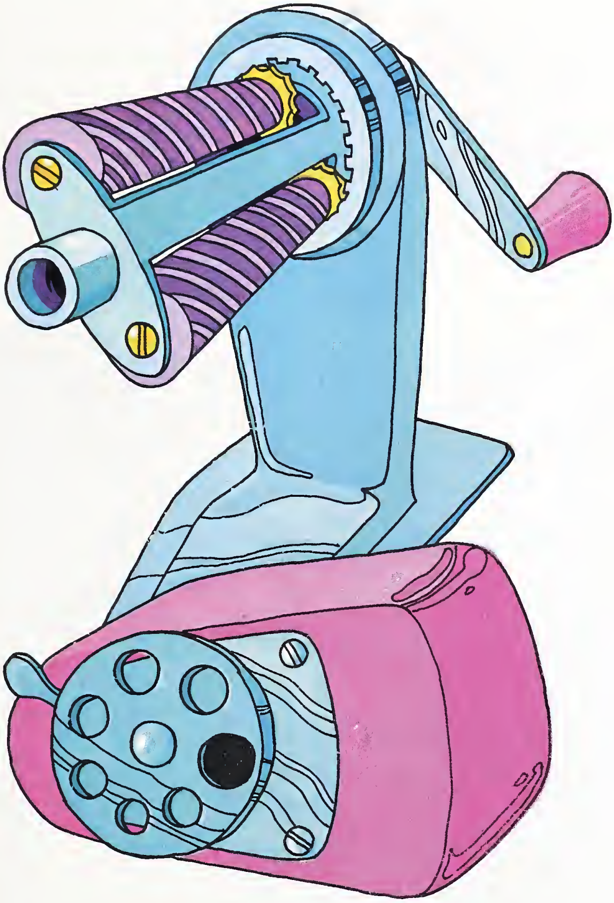
—identify the simple machines which make up some compound machines;

—explain how some compound machines help people do work.

Important words: compound machine.

Sample answers for the caption: Short blades and long handles are best for cutting wire. Long blades and short handles are best for cutting paper. Long-handled scissors put the force where it is needed—at the blades. The short-handled scissors are harder to close, but they cover a greater distance.

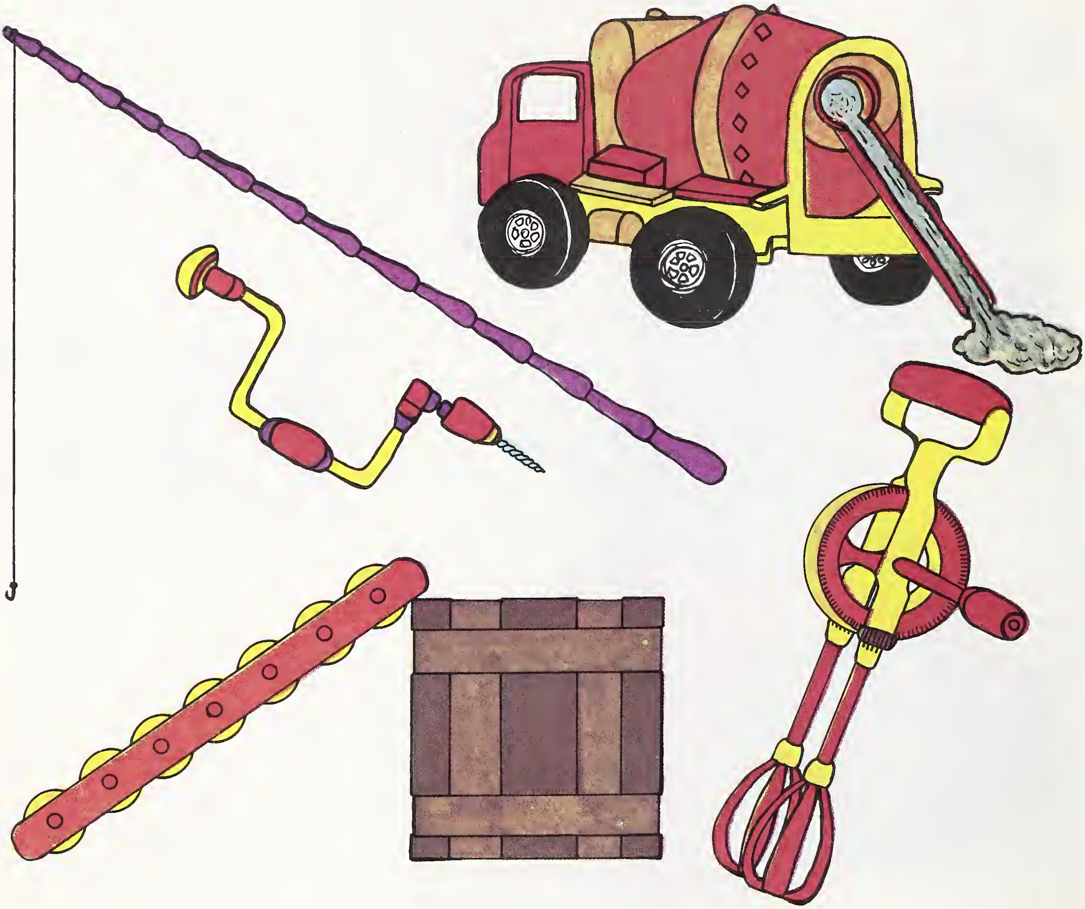
Another compound machine is the pencil sharpener. It has wedges, screws, wheel and axles, and gears all working together. Imagine, all these things just to put a point on your pencil! See if you can point out all the simple machines in the drawing below.



Teaching helps for the picture above: The crank on the pencil sharpener is the wheel. When that is turned, the axle automatically turns. The axle is connected to gears which, in turn, move the grooved areas which sharpen the pencil. These grooves are wedges. The cover of the pencil sharpener has different holes on a wheel and axle. The entire pencil sharpener is held in place with screws.

Find the hidden machines

There are many other compound machines. Some of them are pictured on this page. What work does each one do? What simple machines make up each one?[1]



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[1] **Sample answers:** Fishing pole: hook that catches the fish is a wedge; when held, it is a lever with the hand serving as the fulcrum. Cement truck: wheel and axle for moving; inclined plane for flow of cement. Eggbeater: crank is a wheel which turns the axle, which in turn, turns the gears and beaters. The blades are wedges which help mix the liquid. Inclined plane with rollers: rollers move the load along wheels and axles. Drill: lever and screw; makes holes.

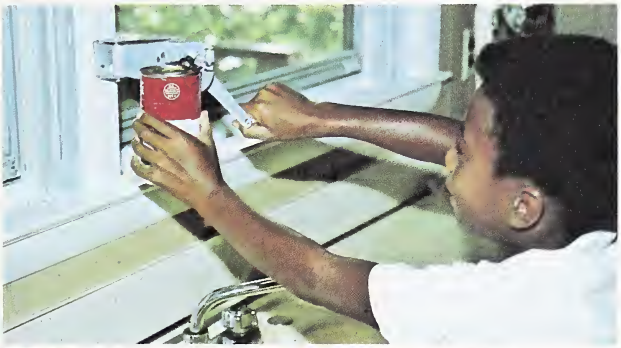
Using compound machines

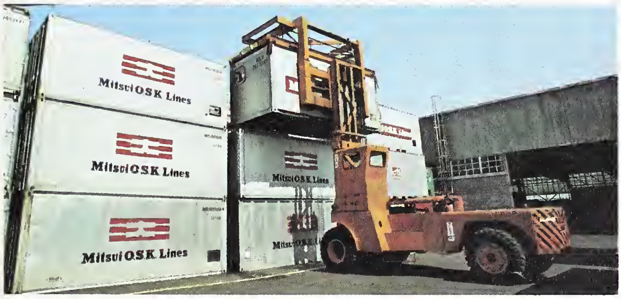
Have you ever seen a building or a road being built? If so, you may have seen many compound machines being used. Building and road workers have to dig down into the ground and move rocks and earth. They may use a bulldozer or a power shovel to do these things. What are some other compound machines used for building roads and buildings? [1]

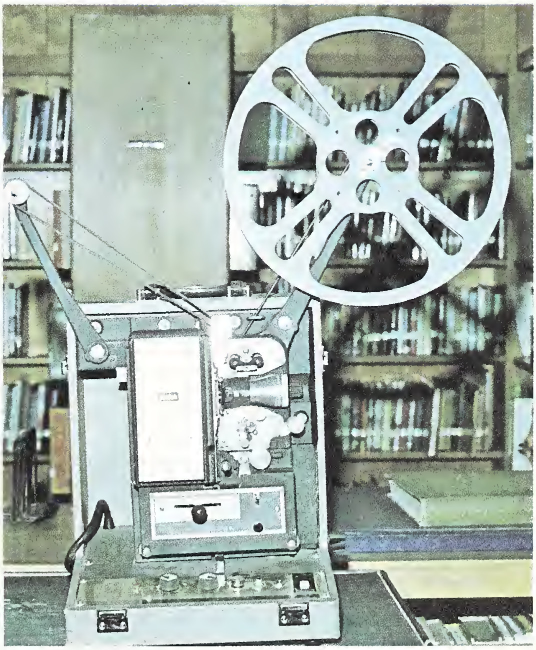
Many compound machines are also used around homes and in parks. Each summer, grass is cut, trees are cut down, and bushes are moved and planted. In the fall, leaves may have to be taken away. In winter, snow and ice may have to be taken away from streets and sidewalks. What compound machines are used to do these things? [2]

[1] **Sample answer:** Shovels, cement trucks, tow trucks, picks.

[2] **Sample answer:** Lawn mowers, rakes, wheelbarrows, shovels, saws, hedge clippers, snowplows, shovels, picks.







Suggested discussion: After the pupils have read the text and looked at the pictures on this page, you might promote a discussion by asking these questions: What are these machines? Why are they used? How are they used? What simple machines make up each one? (Sample answers: Can opener, film projector, and forklift truck. The can opener has a wedge to cut the can, the wheel and axle and the gears turn and open the can. The projector has a pulley which turns the large wheel and axle to move the film. The truck has wheel and axle machines, gears, inclined planes, and wedges.)

Although compound machines can help people do work, they can also help people have fun. Machines are often used in sports. When people fish, they may use a fishing rod and reel. A fishing rod and reel is a compound machine. Bicycling and skiing are other sports in which compound machines are used. What compound machines are used in each of these sports?[1] What are some other sports in which compound machines are used?[2]

Many toys and games are also made of compound machines. What are some toys and games you have seen that are made up of such machines?[3]

[1] **Sample answer:** Fishing: lever, wedge, wheel and axle. Bicycling: wheel and axle, gear. Skiing: wedge, inclined plane, lever.

[2] **Sample answer:** Baseball, hockey, tennis, pole vaulting, skeet shooting.

[3] **Sample answer:** Pool, darts, hockey and basketball games, road-racing sets, miniature electric trains.

A Second Look

1. What is a compound machine?
2. What are some compound machines? What simple machines are in each one?
3. What are some ways in which compound machines are used?

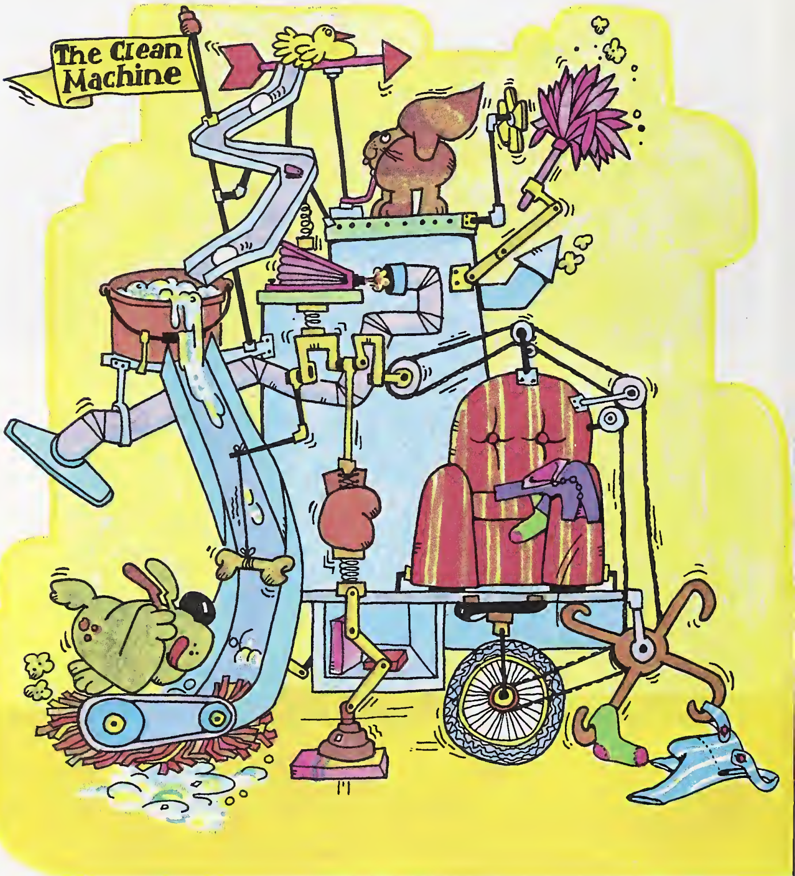
Sample answers for "A Second Look": 1. A compound machine is a machine made up of two or more simple machines. 2. Scissors: wedge and lever. Pencil sharpener: wheel and axle, gears, wedges. Eggbeater: wheel and axle, gears, wedges, lever. 3. Building roads and buildings, sports, and games.

4 Why work at all?

Did you ever think about not doing any work? Sometimes that is fun to think about. You might think about having a machine do everything. It could write your schoolwork for you. It could clean your room. It could wash and dry dishes, and put them away. What other work would you like to have done for you?

While machines can help you do some work, they cannot do all the work. Each day you have to lift some things. Each day you have to push or pull other things. What might some of those things be?[1]

[1] **Sample answer:** Brushing hair and teeth, getting dressed, eating, lifting schoolbooks, writing.



Main concepts of the chapter (pages 132–139):
The force of gravity pulls things to the earth.
A force is needed to start things, to stop things, and to keep things moving.
Friction comes about when things are rubbed.
While friction can be a problem in doing work, it can also be helpful.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

—state that gravity is a force which pulls things to the earth;
—identify that there is a force needed to start, to stop, and to keep things moving;
—explain friction as a force made when things are rubbed together;
—describe ways in which friction is both helpful and a problem.

Important words: gravity, friction.

Why lift?

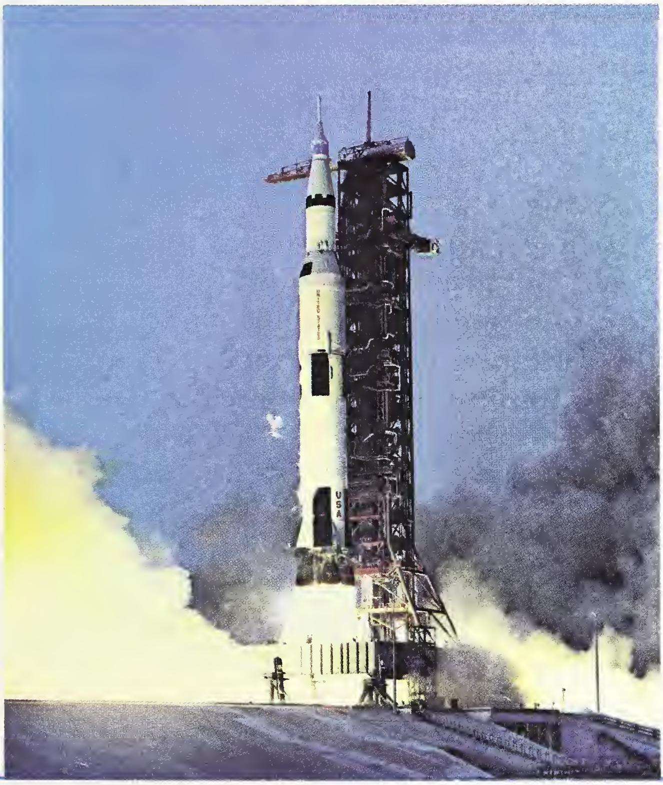
When you lift something, you use your force to lift against another force. That other force is called *gravity* [GRAV-uht-ee]. Gravity is the force which pulls things to the earth.

When you drop your pencil, the force of gravity pulls it down. When you pick it up, you use your force to lift against gravity. Do you think gravity pulls down on all things with the same force? Why or why not?[1]

People use many machines to work against gravity. Inclined planes, elevators, and even space rockets are such machines. What are some other machines which work against gravity?[2]

[1] **Sample answers:** No. Some things are heavier than others and are pulled down with more force.

[2] **Sample answer:** Pulleys, escalators, hoists, cars and trucks going up a hill.



Suggested research: After discussing the material on this page, you might have your pupils research information about rocket launchings. Have them find out how much force is needed to get a space rocket out of the pull of gravity.

Though people often work against gravity, gravity can also be helpful to them. In what ways do you think this is so? [1]

[1] **Sample answer:** It keeps things from floating in the air. It helps keep things in open containers, like water in a glass.

Why push and pull?

Besides lifting things, you also push and pull things each day. One reason why you push or pull things is to start them moving. Things cannot move by themselves. That is, all things will stay still until a force causes them to move.

You have most likely felt this while riding in a car. When the car started to move, you seemed to be forced back. This is because you were sitting still. The car forced you to move along with it.

FINDING OUT

How can you show that a force is needed to move something?

You will need: paper, penny

- Place the paper on the edge of a table.
- Place the penny on top of the paper.
- Quickly pull the paper away.

What happened to the paper? Why?
What happened to the penny? Why?

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: The paper can be pulled away by the force of a quick jerk, and the penny can remain still. Since there is no force applied to the penny, it will not move.
Additional information: After the pupils have completed the activity, you might ask them if they have ever seen a magician remove a tablecloth from a table and leave all the plates, glasses, and food behind. If so, you might tell them that there is really no magic involved but that it is the same principle by which they have moved the paper and left the penny behind.

The force needed to start things moving may come from you, a machine, or even the wind. What are some machines that are used to start things moving? [1]

A windmill uses the force of the wind to pump water out of the ground. What are some other things which are run by the force of the wind?

Just as a force is needed to start something moving, a force is needed to stop something from moving. So you may have to push or pull something to stop it from moving.

You may have had to pull on a wagon to stop it from rolling down a hill. Or you may have had to push a door to stop it from swinging into you. What are some other things you might push or pull to stop them from moving? [2]

For You to Think About

Do you think using seat belts in cars is important? Why or why not?

[1] **Sample answer:** Engines in cars and boats, jet engines in planes, motors in electric trains and fans.

[2] **Sample answer:** Catching a ball, braking a bike, keeping a pencil from rolling off a desk.

Sample answer for the caption: Sailboats on water and ice. Old windmills were used for grinding grain.

Sample answers for "For You to Think About": Yes. When a car stops suddenly, people continue to move on their own momentum. The seat belts are able to contain the people in place and not let them fall forward.

FINDING OUT

How can you show that a force is needed to stop something?

You will need: 2 small blocks of wood

- Put 1 block on top of the other. Put the blocks on a desk or a table.
- Grab the bottom block, and push both blocks along together.
- After getting some speed, suddenly stop the bottom block.

What happened to the top block? Why?

Why keep pushing and pulling?

As you may remember, pushing and pulling are forces needed to start and stop things. These forces are also needed to keep things moving.

Dragging it out. Suppose you were to push or pull a box across the floor. The box would rub against the floor. This rubbing is called *friction* [FRIHK-shuhn]. It is friction which would make the box slow down and stop. To keep the box moving, you would have to keep pushing or pulling it. What are some other things you have had to keep pushing or pulling because of friction? [1]

[1] **Sample answer:** Desks, chairs, wagons, bicycles.

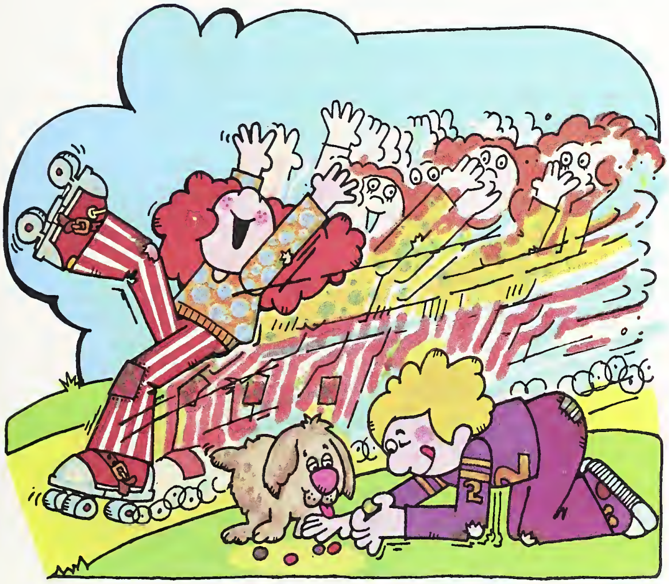
Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: When the bottom block has been stopped, the top block will continue to move. This follows the principle that once something is in motion, it will continue to move. Another force is needed to stop the top block.

People have learned a way to get less friction when they push or pull things. They put loads on things that have wheels. Carts and wagons are such things. Why do you think there is less friction when you use a wheel?[1]

Another problem with friction. Besides making things hard to move, friction can cause another problem. Did you ever fall on a sidewalk? If so, you may have seen and felt what friction can do. As your hands or knees rubbed against the walk some of your skin may have been rubbed off. Friction can wear things away. Look at your pencil. What things on it have been worn away by friction?[2]

[1] **Sample answer:** The wheel turns so the same two surfaces aren't rubbing together.

[2] **Sample answer:** The point, the eraser.

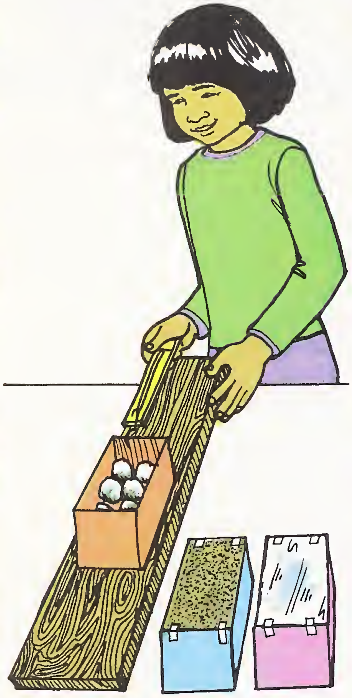


What things in this picture have been worn away by friction?

Sample answer for the caption: Clothes in the well-worn and patched areas, shoes, skates, and sidewalks.

Many machines have moving parts. As these parts move they rub against each other. Friction can wear away these parts of machines. People who use machines have learned another way to make less friction. They put oil on the moving parts of machines. Why do you think oil helps make less friction? 1

[1] **Sample answer:** Oil forms a thin layer between the surfaces and separates them from direct rubbing.



FINDING OUT

How can you change the amount of friction when doing work?

You will need: 3 shoeboxes, 5 or 6 rocks, glue or tape, board, sandpaper, waxed paper, spring scale

- Glue or tape sandpaper to the bottom of 1 box.
- Glue or tape waxed paper to the bottom of another box.
- Leave 1 box plain.
- Using the spring scale, pull each box across the board. Write down the force needed to pull each box.
- Pull each box across the board with all the rocks inside. Write down the force needed for each box.

Which test made the most friction? Why?
Which test made the least friction? Why?
How else might you change the amount of friction when doing work?

Teaching helps for "Finding Out":
Processes used: comparing, observing, measuring, inferring, interpreting data.
Sample findings: The box with the sandpaper and all the rocks will create the most friction. The most friction will make the box hardest to move. This will be measured by the largest amount of force of the spring scale needed to move the box. The least amount of friction would be made by the smooth box with no rocks. The amount of friction depends on the surfaces which are rubbing together and the weight of the object being moved.
Additional information: If the pupils would like to increase the amount of friction, you might suggest covering the board with sandpaper or other rough covering. To decrease the amount of friction, cover the board with aluminum foil, and add some water.

Friction . . . the good side. Think about riding down a hill on a bicycle. As you near the bottom you see a stop sign. You stop. You look both ways and then go. A simple thing? Your hand or foot pressed the brakes. The brakes rubbed against the wheel. This rubbing caused friction which helped you stop. When else is friction helpful in stopping? 1

Have you ever slipped on a wet floor? If so, you know how important friction is in walking. Why do you think people pour sand on icy roads? 2 At what other times might people want to make more friction? 3

[1] **Sample answer:** When running, when riding in a car.

[2] **Sample answer:** To increase friction.

[3] **Sample answer:** Grooves are put on highways to increase friction during rain. When filing nails, when sanding wood.

A Second Look

1. What is gravity?
2. Why do people have to push and pull things?
3. What is friction?
4. In what ways is friction a problem? In what ways is friction helpful?

Sample answers for "A Second Look": 1. Gravity is a force which pulls things toward the earth. 2. Things that are not moving cannot move by themselves. A push or a pull is needed to start all things moving. 3. Friction is the rubbing together of two or more things. 4. Many things have to be continually pushed or pulled because friction makes them slow down and stop. Friction causes things to wear. Friction is helpful because it helps other things to stop and keeps things from running into one another.

Workers Who Use Science

Machines can help people do many kinds of work. There is even a machine which can run other machines. This machine is called a *computer* [kuhm-PYOOT-ur].

Computers can run the machines that make things. They can run machines that make clothes. Many books, such as the one you are reading, were made with the help of a computer.

Though computers can run other machines, many people are needed to help run computers. *Computer programmers* are people who set up computers to do a certain kind of work. These people may "teach" a computer how to run other machines.

Computer operators are people who run computers. They make sure a computer is working the way it should.

To find out more about people who use computers, try to find answers to these questions:

What else do computer programmers and computer operators do?[1]
What other kinds of machines can computers run?[2]
How fast can computers work?[3]
Can computers be used to think?[4]

Along with sources of your own, writing to computer companies and computer-training schools near you may be helpful. Information in reference books under the heading *computers* can also help you find answers to your questions.

Sample answers for "Workers Who Use Science":
[1] If there is a problem to be solved, computer programmers type out the questions to the computer. Upon receiving an answer, computer operators translate the answer into everyday language.
[2] Computers can drive cars, control traffic lights, and correct tests given in schools.
[3] Computers can work faster than any person or group of people working together. Many computer problems can be solved in less than a second.
[4] Not really. They can be taught how to solve problems, but they have no ability to think and understand on their own.

Reviewing the Main Ideas

When you work, you use force to move something.
Machines are used to help make work easier.
There are six simple machines. They are the inclined plane, wedge, screw, lever, wheel and axle, and pulley.
Compound machines are made up of two or more simple machines.
Gravity is the force which pulls things to the earth.
A force is needed to start things moving.
A force is needed to stop things from moving.
A force is also needed to keep things moving.
Friction comes about when things are rubbed together.
While friction can be a problem in doing work, it can also be helpful.

Reading About Science

Horwood, R.H. *Bicycles.* Toronto, Ontario: Macmillan Company of Canada Ltd., 1975.
James, Elizabeth. *The Simple Facts of Simple Machines.* Agincourt, Ontario: Gage Publishing Limited, 1975.
Lefkowitz, R.J. *Push! Pull! Stop! Go! A Book about Forces and Motion.* Scarborough, Ontario: McGraw-Hill Ryerson Limited, 1975.
Meyer, Jerome S. *Machines.* How Things Work Series. Willowdale, Ontario: Nelson, Foster and Scott Ltd., 1972.
Mitgutsch, Ali. *World on Wheels: Rolling Along from Ancient to Modern Times.* Stratford, Ontario: Scholars' Choice Ltd., 1975.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 142.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to the topics of work and machines. Such articles might be found in reference books under the headings *motion, speed,* and *gravity.*

Testing for Understanding

Ideas to Check

On your paper write *T* for each sentence below that is true. Write *F* for each sentence that is false.

T 1. A force is always needed to move something.
T 2. Simple machines can help people do work.
F 3. The wheel and axle is a kind of compound machine.
T 4. Screws are sometimes used to push or pull things.
T 5. Friction can sometimes be helpful.
T 6. Machines are used in some sports and games.
F 7. A pulley is a kind of compound machine.

Words to Use

Write on your paper the word or words that best fit in each blank below. Choose from these words: *force, wedge, wheel and axle, gravity, lever, pulley, inclined plane, friction.*

1. Work depends on how far something is moved and how much ____ is needed to move it. force
2. Things are pulled to the earth by a force called ____. gravity
3. A knife is a kind of ____. wedge
4. A load arm, a force arm, and a fulcrum make up a ____. lever
5. A doorknob is a kind of ____. wheel and axle
6. A staircase is a kind of ____. inclined plane
7. The rubbing which makes things slow down and stop is called ____. friction

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Work and Machines" are provided for you on page T18 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22 of the Teacher's Manual.

Having Fun with Science

Brainteasers

1. Mr. Strong says his arm is a simple machine. Which kind does he mean?[1] How does it work?[2]
2. How is a screw like an inclined plane?[3]

Guessing Game

Move something in your classroom with a simple machine. Don't let others see you move it. Have them guess which simple machine you used.

The Sleeping Elephant

Draw pictures of how you might move a sleeping elephant from the zoo to your home. You can use any machines you want. (No fair waking the elephant!)

Spaceship

There is little or no gravity in space. Your classroom is up in space. What changes would you have to make in some of the things you do?

The Inventor

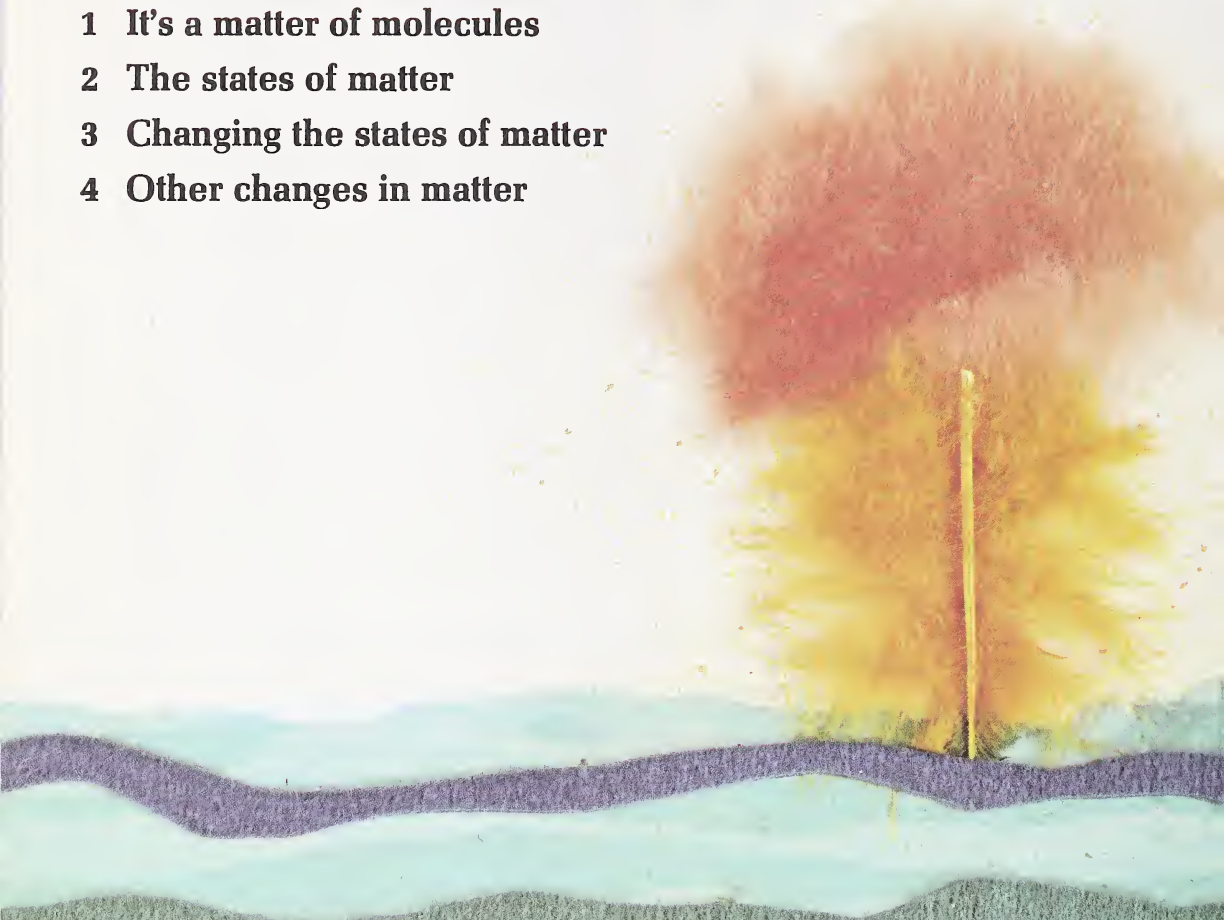
Make up a story about a person who builds a new machine called The Great Duzzitall. What does it do? How does it work? How big is this machine? How much does it cost? Read or tell your story to your classmates.

For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of "Work and Machines." You may also wish to encourage the pupils to make up additional activities related to work and machines.

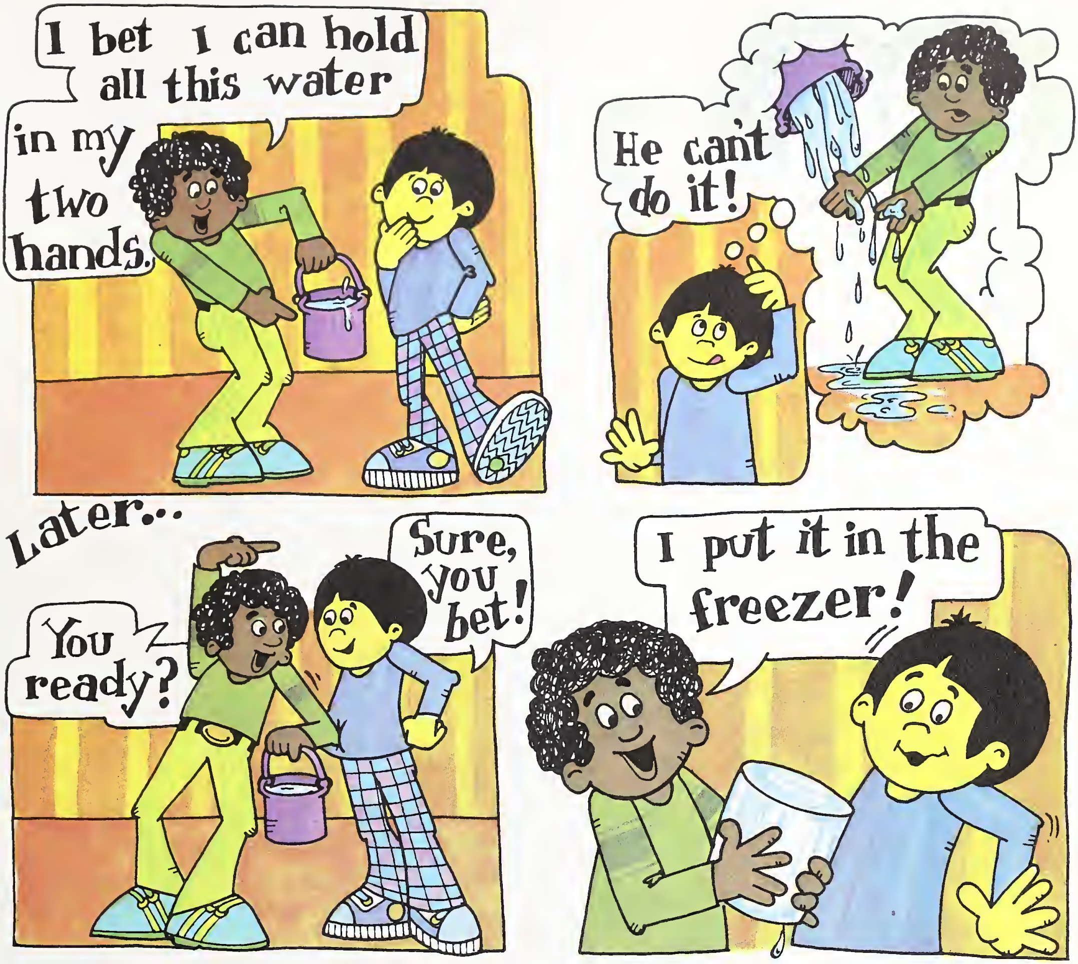
Sample answers for "Brainteasers": [1] Lever. [2] The elbow is the fulcrum, the muscle in the lower arm is the force, and an object in his hand is the load. [3] A screw is an inclined plane that goes around in circles.

4 Solids, Liquids, and Gases

1 It's a matter of molecules
2 The states of matter
3 Changing the states of matter
4 Other changes in matter



Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see pages T13–T14 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit and have the pupils begin collecting these materials. These activities are found on pages 154, 156, 161, 165, 168, 172, 179, 180, and 186.


I bet I can hold all this water in my two hands.
He can't do it!
Later...
You ready?
Sure, you bet!
I put it in the freezer!

How did the water change?[1]
Why might people want to freeze water?[2]
What are some other ways you have seen water change?[3]

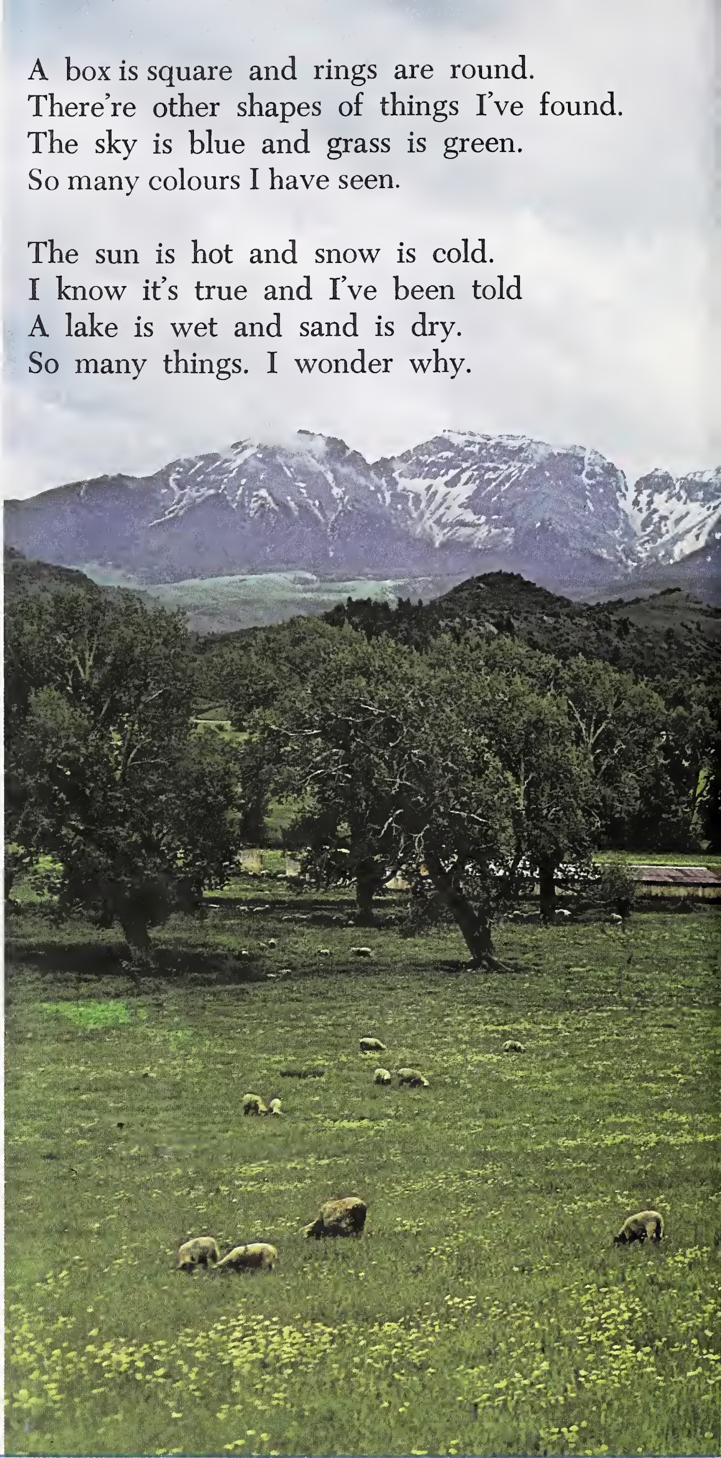
Introducing the unit: You may wish to have the pupils read the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:
[1] It froze, or became a solid.
[2] To skate, to make popsicles.
[3] Melting, forming dew, steaming.

1 It's a matter of molecules

A box is square and rings are round.
There're other shapes of things I've found.
The sky is blue and grass is green.
So many colours I have seen.

The sun is hot and snow is cold.
I know it's true and I've been told
A lake is wet and sand is dry.
So many things. I wonder why.



Main concepts of the chapter (pages 146–152): The things around you differ in many ways. The things around you are alike in many ways. Anything that takes up space is called matter. All matter is made up of molecules.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

- —identify some of the ways that matter may differ;
- —identify some of the ways that matter is alike;
- —state what matter is and what makes up matter.

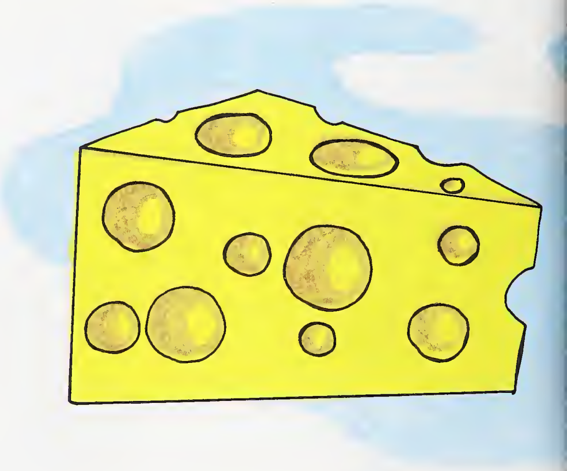
Important words: space, matter, molecules.

A tree is big and ants are small.
There're things I see; some not at all.
The wind is strong and lambs are tame.
So many things . . . and none the same.

Suggested activity: After the pupils read the poem on pages 146 and 147, you might have the pupils discuss the poem. After reading the last line, you might have them think of other things that are not the same and have them write a poem about these different things.

What's the difference?

Suppose you were to travel around the world. You would most likely see many of the things talked about on pages 146 and 147. It would not take very long before you would see that these things are not the same. But you would not have to go around the world. Instead you could look at the things which are near you. What things would you see that are not the same? [1]



The things around you differ in many ways. They may have different shapes, colours, and sizes. Some things are living. Some things are not living. Even some things that look the same may be different in other ways. In what ways might these be different? [2]

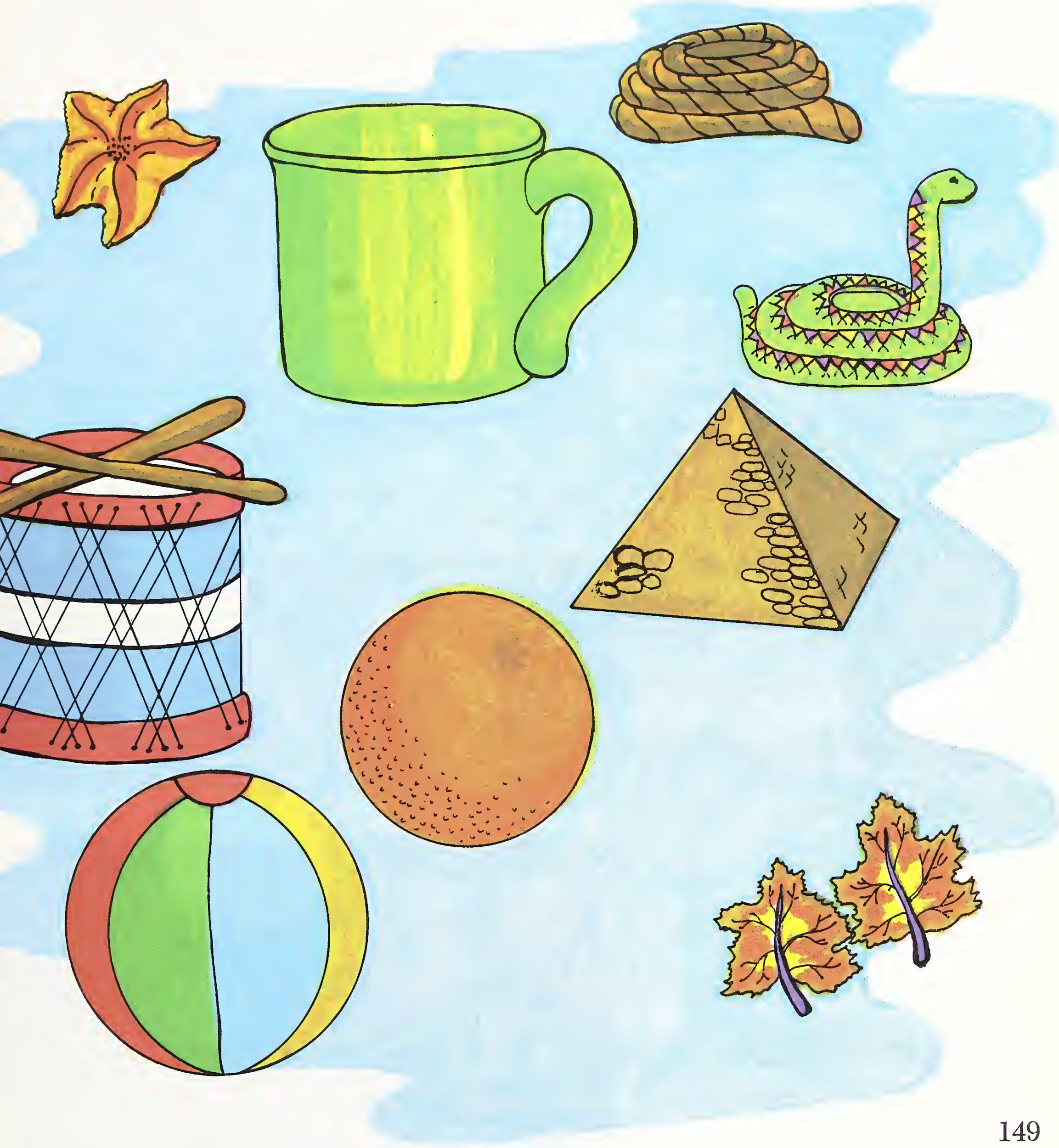
For You to Think About

Salt and sugar look the same. But how are they not the same?

[1] **Sample answer:** People, clothing, things in desks and on desks.

[2] **Sample answer:** Texture, taste, smell, hardness, softness.

Sample answer for "For You to Think About": Taste.



Teaching helps for the pictures above: You may wish to use the pictures above to initiate a discussion that will help the pupils understand the ways in which things differ in colour, shape and size. Each of the things pictured can be matched up with some other object on the page. You might ask the pupils which objects are the same colour but are different in size or which objects have the same shape but differ in colour, etc.

Just alike

Though things around you may differ in many ways, they are also alike in some ways.

A place in space. One way these things are alike is that they take up *space,* or room. Big things take up a lot of space. Small things take up little space. Do you think two things can take up the same space at the same time? Why or why not? [1]

Anything that takes up space is called *matter.* A speck of dust may not take up much space, but it is matter. Even you are matter. What is some matter that takes up a lot of space? [2]

Tiny parts. Besides taking up space, all matter is alike in another way. All matter is made up of *molecules* [MOL-ih-KYOO(UH)LZ]. A molecule is the smallest form of matter. Molecules are very, very tiny. In fact, just one drop of water is made up of millions and millions of water molecules! Do you think you could ever see a molecule? Why or why not? [3]

[1] **Sample answers:** No. Because when something moves, other things are pushed away.

[2] **Sample answer:** Buildings, mountains, cities, oceans.

[3] **Sample answers:** No. A single molecule is too small to be seen.

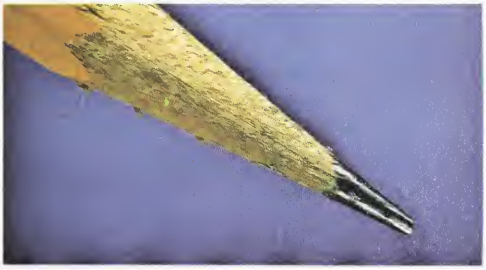
Suggested research: After the pupils read the last paragraph on this page, you might tell the pupils that there are special machines called microscopes which can help people see things that are very small. You might have them find out what a microscope is and which kind of microscope is used to study molecules.

There are many kinds of molecules. This is one reason why there are many kinds of matter. The molecules which make up a key are different from the molecules which make up a flower. You are made up of many different kinds of molecules.

There is another reason why there are so many kinds of matter. Sometimes the same kinds of molecules join together in different ways. The molecules which make up the point on your pencil are joined together in one way. These same kinds of molecules can join together in another way to make a diamond for a ring.

Why do you think it is important for molecules of matter to join together? [1]

[1] **Sample answer:** So they can make up different kinds of matter.



A Second Look

1. In what ways do things around you differ from each other?
2. In what ways are things around you alike?
3. What is meant by matter?
4. What are molecules?

Sample answers for "A Second Look": 1. Things differ in shape, colour, and size. 2. All things take up space and are made of molecules. 3. Matter is anything that takes up space. 4. Molecules are the smallest forms of matter.

2 The states of matter

As you may know, there are many kinds of matter. But matter can be found in only three states, or forms. One state is the *solid* [SOL-uhd] *state*. The chair you sit on and the floor you walk on are solids.

Another state of matter is the *liquid* [LIHK-wuhd] *state*. The water you use for drinking and washing is a liquid.

A *gas* is the third state of matter. The air you breathe is made up of many gases.

Look at the pictures below. They show some matter in different states. What things in the pictures show solids? What things show liquids? What things show that there are gases? [1]

[1] **Sample answers:** Solids: the boat, the sand. Liquids: the lake, the ocean. Gases: the wind in the sail, the air in the bubbles.

Main concepts of the chapter (pages 152–162):
Matter can be found in three states—solid, liquid, and gas.
Solids have a shape and size of their own.
Liquids do not have a shape of their own.
Gases have neither shape nor size of their own.
The states of matter act differently because of the movement of their molecules.

Performance objectives: After studying the information provided in this chapter, the children should be able to
—name the three states of matter;
—explain how the movement of molecules is different in each state of matter.

Important words: solids, liquids, gases, oxygen, carbon dioxide.

Solids

Probably most things around you are solids. Rocks and buildings are solids. What are some solids you see around you? [1]

Though solids may differ in many ways, they are alike in some ways. One way is that solids have a shape of their own. That is, the shape of a solid does not change by itself.

You, however, can change the shape of a solid. You might change the shape of a piece of paper by folding it. In what other ways might you change the shape of a solid? [2]

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[1] **Sample answer:** Walls, floor, desks.

[2] **Sample answer:** Breaking, bending, cutting, sawing.

Teaching helps for the picture above: After the pupils read about solids on this page, you might ask them to look at the picture and point out all the solid things they find in it.

Solids are alike in another way. Suppose you change the shape of a solid by bending or breaking it. The solid will still take up the same amount of space. No matter how tightly you might wad up a piece of paper, it will still take up the same amount of space.

There is a reason why solids act the way they do. That reason has to do with their

FINDING OUT

How can you measure the amount of space taken up by a solid?

You will need: measuring cup, 5 differently shaped solids (Pick some solids that can change shape easily.)

- Half fill a measuring cup with water.
- Carefully put 1 solid into the water.
- Write down how much the water level rose.
- Take the solid out of the water.
- Do the same test with the other 4 solids.

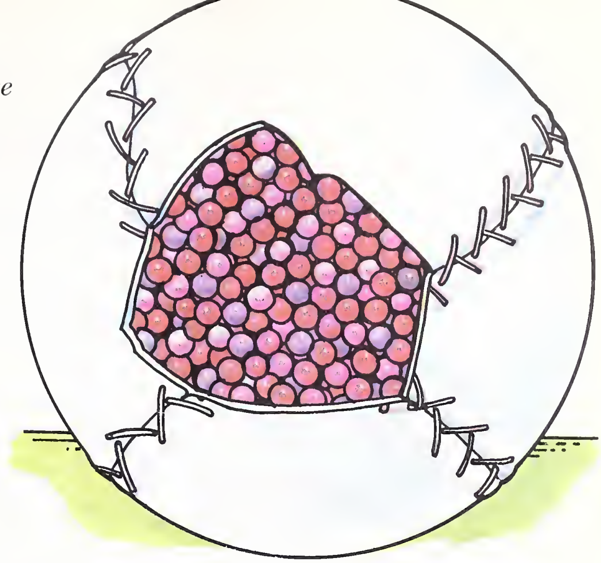
Did all the solids take up the same amount of space in the water? How can you tell?

- Change the shape of some of the solids.
- Place each of the newly shaped solids in the water one at a time.
- Measure how much space each takes up.

Does each of these solids take up the same amount of space as it did before? Why or why not?

Teaching helps for "Finding Out":
Processes used: measuring, observing, comparing, hypothesizing.
Sample findings: The water level in the cup will rise according to the size of the object put in the cup. It is possible for different-shaped solids to take up the same amount of space. The broken, bent, or otherwise new shape of the solid will take up the same amount of space as it did in its original shape.

The coloured circles in this picture represent the molecules in this solid. Would it be easy to change the shape of this solid? Why or why not?



molecules. You may remember that all matter is made of molecules. These molecules are always moving. But the molecules which make up a solid are very close together. These molecules are packed so close together that they do not have much room to move. This is why solids keep their own shape.

Liquids

Another state of matter you see each day is the liquid state. Fruit juices and milk are some liquids. What other liquids can you name?[1]

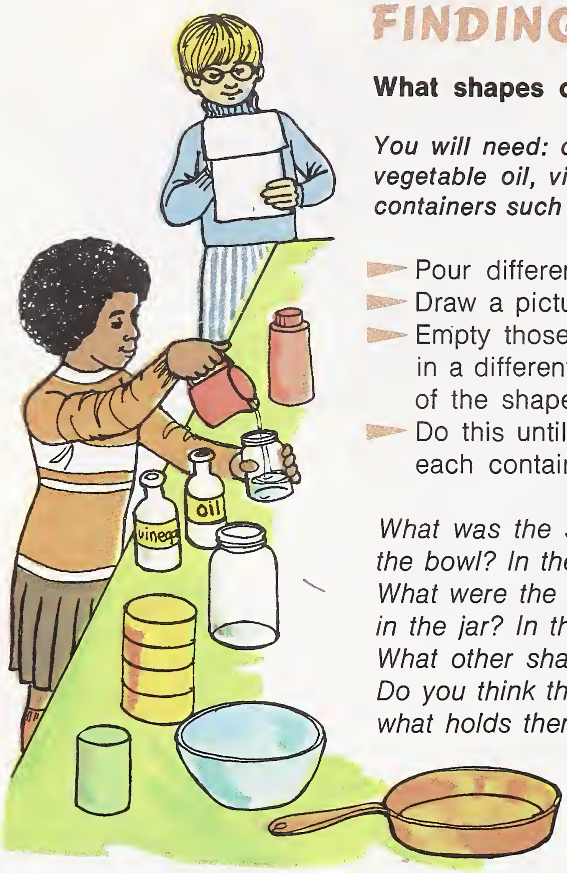
Liquids are different from solids in many ways. Suppose you were to close your eyes and touch some solids and liquids. In what ways would solids and liquids feel different from each other?[2] How else are liquids and solids different from each other?[3]

[1] **Sample answer:** Water, soda, tea.

[2] **Sample answer:** Solids feel firm while liquids flow through your fingers.

[3] **Sample answer:** Liquids are wet and can be poured, whereas solids are dry and most of them cannot be poured.

Sample answer for the caption: The force of a baseball bat may flatten the ball somewhat when it is hit. But this would have to be a very hard hit because the molecules of the ball are packed very closely together.



FINDING OUT

What shapes do liquids take?

You will need: different liquids such as water, vegetable oil, vinegar, and rubbing alcohol; different containers such as jars, bowls, cans, bottles, and pans

- Pour different liquids into different containers.
- Draw a picture of the shape of the liquids.
- Empty those containers and pour each liquid in a different container. Again, draw a picture of the shape of the liquids.
- Do this until each liquid has been poured into each container. Draw pictures of each shape.

What was the shape of the water in the jar? In the bowl? In the can?
What were the shapes of the oil and the vinegar in the jar? In the bowl? In the can?
What other shapes might be formed by a liquid?
Do you think the shapes of all liquids depend on what holds them? Why or why not?

Have you ever spilled water? If so, what was the shape of the water before you spilled it? What was the shape of the water after you

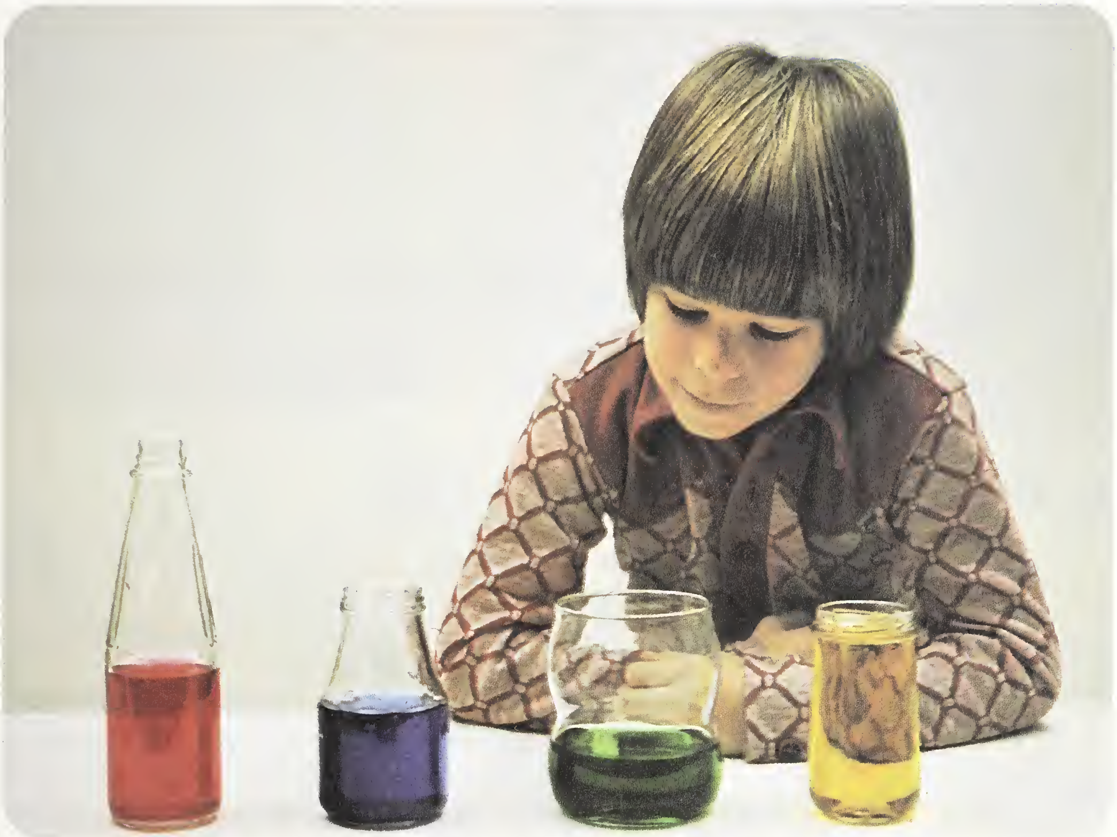
Teaching helps for "Finding Out":
Processes used: observing, communicating, hypothesizing.
Sample findings: All the liquids will take the shape of the container.

Extending the "Finding Out": At this time, you may wish to have the pupils draw some different shapes in which a liquid might be found. For each drawing, they may identify what would make the liquid take the shape they have drawn.

spilled it? Unlike solids, liquids do not have a shape of their own. What might be the shapes of some liquids? What would make them take those shapes?[1]

Look at the picture below. Which liquid do you think takes up the most space? If all these liquids were placed in containers that were alike, would you make the same guess? Why?

[1] **Sample answers:** Square, round. Their container.



Teaching helps for the activity shown above: After the pupils have looked at the different-coloured liquids in each jar or bottle, have them guess which has the most liquid in it. Then have the pupils turn to page 158 to look at the same liquids in identical containers. You may wish to point out that the change of shape of a liquid does not change the amount.

Liquids are like solids in one way. They cannot change in size by themselves. One cupful of water may be poured in a pan or on a table. But it is still one cupful of water. It still takes up the same amount of space.

There is a reason why liquids act as they do. Like solids, the reason has to do with their molecules. The molecules which make up a liquid are not as close together as the molecules in a

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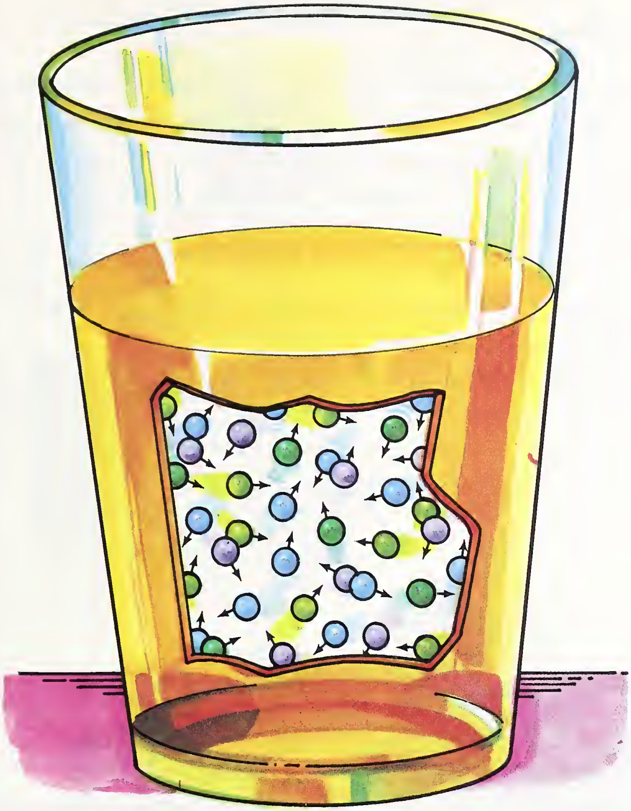
Suggested activity: After the pupils have compared the pictures on pages 157 and 158, you might have them pour the same amount of liquid into different containers. Have them discover which containers make it seem as though there were more liquid and which containers make it seem as though there were less liquid.



As the molecules in this liquid move, they bump not only into each other but also into the sides of the container. How might you change the shape of this liquid?

solid. Molecules in a liquid have more room to move. They can move about to form many shapes.

Although liquids and solids are different in many ways, some things act like liquids *and* solids. It may be hard to tell what these things are. In which state do you think mayonnaise is? Egg yolks? Toothpaste?[1] What are some other things which act like both liquids and solids?[2]

[1] **Sample answer:** Somewhere between a solid and a liquid.

[2] **Sample answer:** Paste, mustard, tomato paste.

For You to Think About

Salt sometimes acts like a liquid. It can be poured from one container into another. Salt can fill and take the shape of any container. But how do you know it is a solid and not a liquid?

Sample answer for the caption: Pouring the liquid into another container would change its shape. **Sample answer for "For You to Think About":** By looking carefully, a person can see that salt is made up of individual grains of solid crystal.

Gases

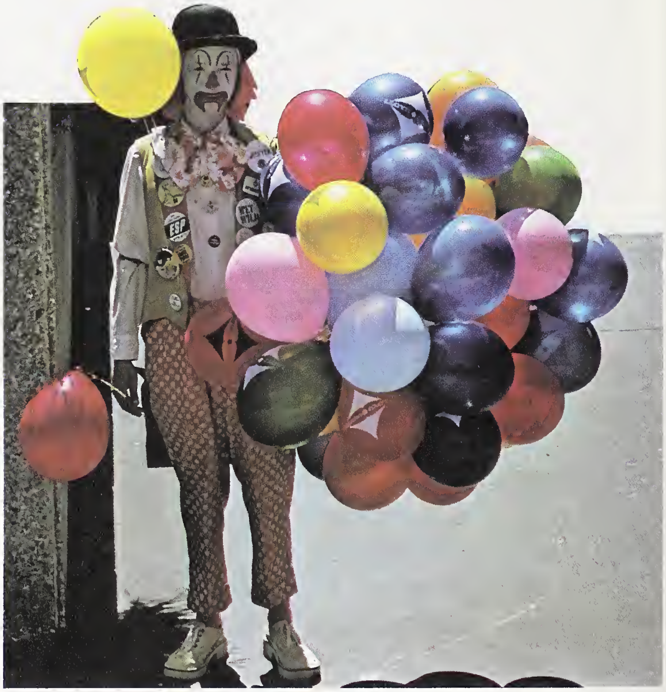
Gases are quite different from both solids and liquids. Most gases cannot even be seen, and most have no colour. But, have you ever felt the wind blow against your face? If so, you were feeling the gases in air.

Feeling gases is one way you may know that they are around you. In what other ways might you know gases are around you?[1]

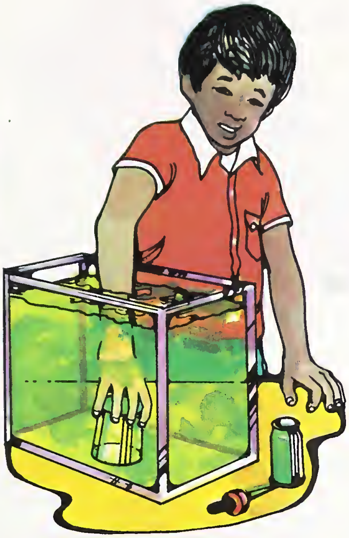
Gases, like liquids, have no shape of their own. Gases can be in many shapes. What might be some of those shapes?[2]

[1] **Sample answer:** Smelling, breathing.

[2] **Sample answer:** Gases take the shape of the matter around them.



Suggested activity: After the pupils read the section about gases, you might have them draw some different shapes of gases. Then have them tell why a gas might be in that shape.



FINDING OUT

How can you show that gases take up space?

You will need: a large container of water with 2 or 3 drops of food colouring added, clear drinking glass

- Turn the glass upside down and push it down in the water.
- When the glass is at the bottom of the container turn the glass over.

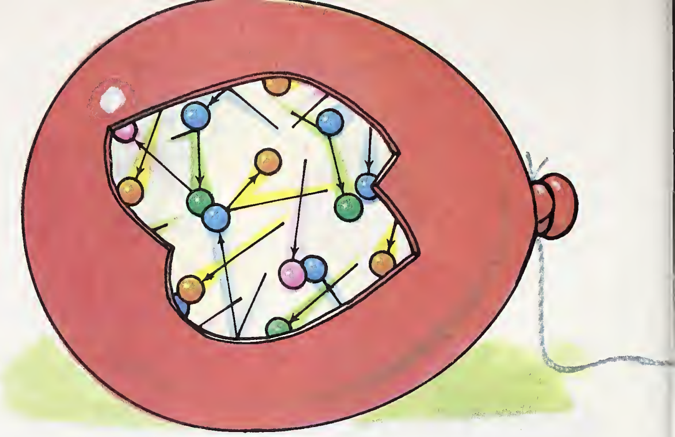
What happened when you turned the glass over? Did the bubbles take up space in the water? How could you tell? (Be careful: Remember you cannot see a gas.)
What do you think the bubbles were made of?

Gases are different from both solids and liquids in that gases can move about by themselves. Therefore, a gas does not always take up the same amount of space. The air which fills a small jar can spread out and take up the space in a large room. The air you breathe can come together to fill the space in a small balloon.

The molecules which make up a gas make it act the way it does. These molecules are much farther apart than the molecules of a liquid. This gives them much more room in which to move.

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: The air will stay in the glass as it is pushed to the bottom of the container. When the glass is turned over, the air will escape and rise to the top. The air can be "seen" only in the sense that it is where the liquid separates to form bubbles.

Compare the way the molecules of air in this balloon are packed with the way molecules are packed in a solid (page 155) and a liquid (page 159).



Because gases can move by themselves, they most often do not stay in one place. When you open a window, some of the air in a room will move outside. Some of the air outside will move inside. Why do you think it is important that air can move? 1

[1] **Sample answer:** Moving air brings fresh air for breathing, causes changes in weather, and helps sailboats move.

The air around you is made up of many gases. One gas in the air is *oxygen* [OK-sih-juhn]. Oxygen is the gas you need to breathe in order to live. Another gas is called *carbon dioxide* [dy-OK-SYD]. This gas is needed by plants to grow. What other gases can you name? 2

[2] **Sample answer:** Nitrogen, hydrogen, carbon monoxide (exhaust from cars).

For You to Think About

You are made of solids, liquids, and gases. Which parts of you are solids? Which parts are liquids? What parts are gases?

A Second Look

1. What are the three states of matter?
2. In what ways are solids different from liquids?
3. In what ways are liquids different from gases?
4. How do the molecules of solids, liquids, and gases differ?

Sample answers for the caption: The gas molecules in the balloon move faster and are farther apart than those in the liquid. The molecules in the liquid move faster and are farther apart than those in the solid.

Sample answers for "For You to Think About": Solids: bones, skin, hair, nails. Liquids: blood, tears, digestive juices. Gases: air in lungs.

Sample answers to "A Second Look": 1. The three states of matter are solid, liquid, and gas. 2. Solids have a shape and size of their own, while liquids have a size of their own but no shape. 3. Liquids have no shape but a size of their own. Gases have neither shape nor size. 4. The molecules in a solid are packed tightly together. The molecules in a liquid are farther apart and move more freely. The molecules in a gas are farthest apart and move very fast.

3 Changing the states of matter

Many years ago there was a story about a king named Midas. Midas, so the story went, had a golden touch. Everything he touched turned into gold!

This story, of course, was told in a time when people did not know much about matter. It was indeed a story of matter and dreams. Why do you think people wanted to believe in the Midas touch?[1]

Although matter cannot be changed with a golden touch, the states of matter can be changed. Some matter can change from a solid to a liquid. Some liquids can change to a gas. In what other ways do you think matter can change states?[2]

[1] **Sample answer:** People would become rich from the gold.

[2] **Sample answer:** Liquid to solid, gas to liquid.

Main concepts of the chapter (pages 163–174):
Matter sometimes changes state.
Melting and boiling are changes of state caused by adding heat.
Freezing is a change of state caused by taking heat away.

Performance objectives: After studying the information provided in this chapter, the children should be able to
—list examples of changes in the states of matter;
—explain different ways in which matter can change from one state to another.

Important words: melting, boiling, evaporation, freezing, dew, water vapour, nitrogen, frost.

Changes made by adding heat

Many changes in the states of matter happen every day. You have most likely seen many of these changes.

Solids to liquids. Have you ever eaten a Popsicle? If so, you may have had to start by biting into something hard. In a short time you may have had to finish the Popsicle by drinking it! It had changed from a solid to a liquid.

A solid cannot change to a liquid by itself. Something has to cause this change. What do you think makes a Popsicle change?[1]

The change from a solid to a liquid is called *melting*. Many solids can melt when enough heat is added to them. What solids have you seen melt?[2]

[1] **Sample answer:** Heat.

[2] **Sample answer:** Ice cube, ice cream, Jell-O.

FINDING OUT

How can you compare the amount of heat it takes to melt different things?

You will need: ice cubes, butter, wax, solid shortening, plastic bags, pan, candle, matches

- Let each solid sit out in the air for 5 to 10 minutes.

Which solids melted?

- Put the rest of the solids in plastic bags and hold them in your hands for about 5 minutes.

Which solids melted?

- Put the unmelted solids in the pan.
- Light the candle.
- Hold the pan over the candle until these solids melt.

Why do you think some things need more heat than others to melt?

Teaching helps for "Finding Out":
Processes used: comparing, hypothesizing.
Sample findings: After ten minutes, the ice cubes may not melt completely, but they will show the most-noticeable change. The other things will most likely not change. The butter and solid shortening will become very soft in the bags but will not be liquids. The wax will not melt until it has been heated in the pan.
Additional information: The molecules in some solids are packed more tightly together than in other solids. A greater amount of heat is needed to break up the tightly packed molecules than is needed for those more loosely packed together.

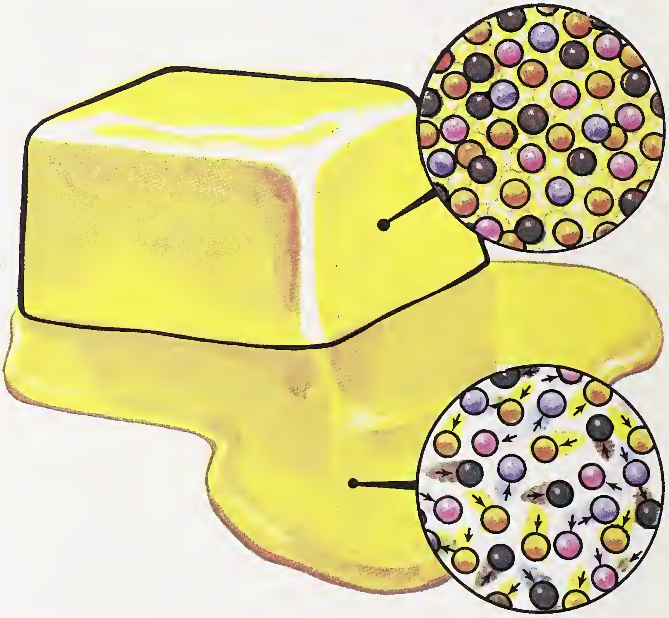
For You to Think About

Some solids, such as wood, do not melt when heat is added to them. What other things can you think of that act in this way?

As you may remember, the molecules in a solid can hardly move because they are packed tightly together. Heat can change the way these molecules are packed. Heat can make the molecules of a solid move faster. The molecules then move farther apart. So, there is more space between the molecules. This is why a solid changes to a liquid when heated.

Some things need more heat than others in order to melt. When the air temperature is about 1°C, ice may melt. Not all solids will melt when the temperature is so low. What solids do you think need to become very hot before they can melt? [1]

[1] **Sample answer:** Things made of plastic or metal.



The molecules pictured in this solid are being heated. In what ways is the solid changing?

Sample answer for "For You to Think About": Paper, cardboard, matches.

Sample answer for the caption: The solid is changing to a liquid.

Liquids to gases. Another change of state is the change from a liquid to a gas. Since you cannot always see a gas, it is sometimes hard to see this kind of change. How might you know that a liquid has changed to a gas?[1]

Just as heat can change the way the molecules in a solid are packed, it can change the way the molecules in a liquid are packed. When enough heat is added to a liquid, the molecules in the liquid move very fast. These molecules also move farther apart from one another. This is why a liquid changes to a gas when heated.

[1] **Sample answer:** The liquid is no longer there.

People often think of the steam shown here as a gas. But this steam is made up of droplets of water. What happens to the steam when it disappears?

Sample answer for the caption: It becomes part of the air.

When a liquid is changing to a gas, it is sometimes called *boiling*. Most liquids can boil. Water boils when it is about 100°C. Some liquids need more heat than others to boil. Why do you think some liquids need more heat than others to boil?[1] When might you want to boil a liquid?[2]

[1] **Sample answer:** Because the molecules of some liquids are packed closer together than the molecules of other liquids.

[2] **Sample answer:** When cooking or cleaning something.

FINDING OUT

What changes can you see in water as it is being heated?

You will need: burner or hot plate, pan

- Pour water in the pan so it is about 3 cm deep.
- Place the pan of water over the burner or hot plate and turn on the heat.
- Watch the water as it is being heated.
- Write down the changes you see in the water.

Do you see bubbles? If so, what are they?
How do the bubbles move?
As the water boils, what do you see above the pan?

- Let the water boil for several minutes before turning off the heat. When the water is cool, measure the water in the pan.

Is the water still three centimetres deep? Why or why not?

Teaching helps for "Finding Out":
Processes used: observing, measuring, inferring, collecting data.
Sample findings: The heat will cause the water in the bottom of the pan to heat first. The heated water molecules break apart near the bottom and become air. Since air is lighter than water, the bubbles rise and become part of the air in the room. The steam above the water can be seen because this air holds a large amount of water. Because the water vapor is escaping into the air, the amount of water will be less in the pan after it has cooled.

Fog is made up of water droplets in the air. What will cause this fog to evaporate?

Another way in which heat changes liquids to gases is by *evaporation* [ih-VAP-uh-RAY-shuhn]. When a liquid evaporates, its molecules become part of the air.

Your clothes become dry after they are washed because of evaporation. Perfume evaporates when it is put on the skin. How might you know that perfume has evaporated? [1]

Solids to gases. When heated, a solid most often changes first to a liquid and then to a gas. A few times, however, a solid can change straight to a gas.

Sometimes a patch of ice on a street or a sidewalk may "disappear." People who live in places where the winters are very cold and dry are more likely to see this happen. This can happen even though the air is not warm enough to melt the ice. When this happens, where do you think the molecules of ice go? [2]

Exploring on Your Own

Sometimes the water in food is evaporated before the food is sold in stores. Powdered milk is one such food. What are some other evaporated foods you can buy? Make a list of evaporated foods you see in a supermarket. Add your list to the lists of your classmates. Find out why some foods are evaporated.

[1] **Sample answer:** The smell moves through the air.

[2] **Sample answer:** They became part of the air.

Sample answer for the caption: Heat from the sun. **Sample findings for "Exploring on Your Own":** Instant tea, soups, or coffee. Cake and pie mixes, fruit drinks, Jell-O. Evaporated foods take up less space in stores and homes and in many cases will be preserved longer.

Changes made by taking heat away

As you have learned, changes such as melting and boiling cannot take place without heat. But matter may also change state when heat is taken away.

Liquids to solids. Matter that can change from a solid to a liquid can change back to a solid. This change of state is often called *freezing*. Freezing takes place when a certain amount of heat is taken away from a liquid.

When heat is taken away from a liquid its molecules slow down and move closer together. When might you want a liquid to freeze? [1]

[1] **Sample answer:** To make ice cubes or to ice-skate.

Suggested discussion: After the pupils have read "Liquids to solids," you might initiate a class discussion by asking the pupils when they think they would not want a liquid to freeze. (Answers may include ice on a sidewalk, frozen soda in a can or bottle, frozen milk in its carton, or freezing rain while walking outside.)

Water behaves differently from most liquids when it freezes. As mentioned in the text, most solids take up less space than the liquids from which they are formed. When water freezes, however, the solid occupies more space than the liquid. This is a very important property of water.

Gases to liquids. As you may remember, when enough heat is taken away from a liquid, the liquid changes to a solid. A gas can also change its state when heat is taken away. It may change to a liquid.

Maybe you have seen tiny drops of water on grass or bushes in the morning. They may not have been raindrops. They may have been drops of *dew*. Dew forms on nights when there is hardly a cloud in the sky. Why do you think dew forms at night?[1]

[1] **Sample answer:** It is usually cooler at night than during the day. Heat from the sun keeps dew from forming during the day.

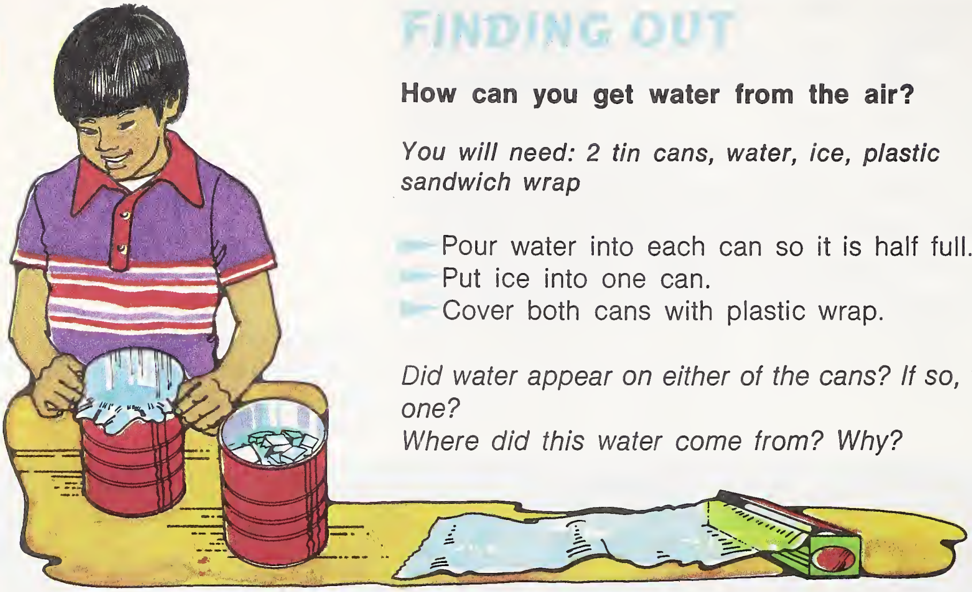
FINDING OUT

How can you get water from the air?

You will need: 2 tin cans, water, ice, plastic sandwich wrap

- Pour water into each can so it is half full.
- Put ice into one can.
- Cover both cans with plastic wrap.

Did water appear on either of the cans? If so, which one?
Where did this water come from? Why?



Did you ever breathe on a mirror and make it cloudy? If so, you were seeing water in the air you breathed out. The air around you also has water in it. This water is in the form of a gas. It is called *water vapour*. When water vapour is cooled, it becomes water again. This is what makes a mirror cloudy and the grass wet with dew. How do you think this water gets into the air?[1]

Sometimes, water vapour in the air helps to form clouds. What happens when this water vapour changes to a liquid?[2]

[1] **Sample answer:** By evaporating.

[2] **Sample answer:** It rains.

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring.
Sample findings: Water will appear on the can with ice as water vapour in the air will condense faster on a cooler object. The amount of humidity (water vapour in the air) of the classroom will determine how fast water droplets will form on the can. Water on the can comes from water vapour in the air.

Most gases must be very cold before they can become liquids. Oxygen, the gas you need to breathe, becomes a liquid at —183°C. Liquid oxygen is used to make part of the fuel for space rockets. *Nitrogen* [NY-truh-juhn], the gas which makes up most of the air, becomes a liquid when it reaches —196°C. Liquid nitrogen is used to make fertilizer to help grow crops for your food.

Oxygen and nitrogen can also become solids. How do you think this change is made?[1]

[1] **Sample answer:** By making them colder.

In blood banks, containers of blood are often stored in liquid nitrogen. The extreme cold keeps the blood cells in good condition until they are needed. When might they be needed?

Sample answer for the caption: When a person has lost a lot of blood and must be given blood, the stored blood cells may help save the person's life.

For You to Think About

Sometimes the freezer part of a refrigerator has to be defrosted. That is, frost has to be melted and taken out to make room for food. Where does the frost come from?

[1] **Sample answer:** Since most gases cannot be seen, no one can see gases when they change.

[2] **Sample answer:** Freezing point of water 0° C.

Gases to solids. Have you ever seen frost on a window? If so, you have seen a solid which has formed straight from a gas. Why do you think you cannot see this change take place? 1

Like dew, frost is formed from water in the air. On cold nights, this water in the air most often forms bits of ice on things near the ground. How cold do you think the air must be so that frost forms instead of dew? 2

A Second Look

1. What is melting? What is freezing?
2. What are some ways in which liquids can change to gases?
3. When might a gas change to a liquid?

Sample answers for "For You to Think About": Water vapour in the air in the freezer condenses and freezes. During seasons in which there is a high degree of humidity, freezers must be defrosted more often than during dry seasons.

Sample answers to "A Second Look": 1. Melting is a change of state from a solid to a liquid when heat is added. Freezing is a change of state from a liquid to a solid when heat is taken away. 2. Liquids may change to gases during boiling and evaporating. 3. A gas may change to a liquid when dew forms near the ground in the morning or when some gases become very cold.

4 Other changes in matter

Although you may see matter change around you each day, there are only two kinds of changes. One kind of change is called a *physical* [FIHZ-ih-kuhl] *change*. When matter changes from one state to another, a physical change takes place.

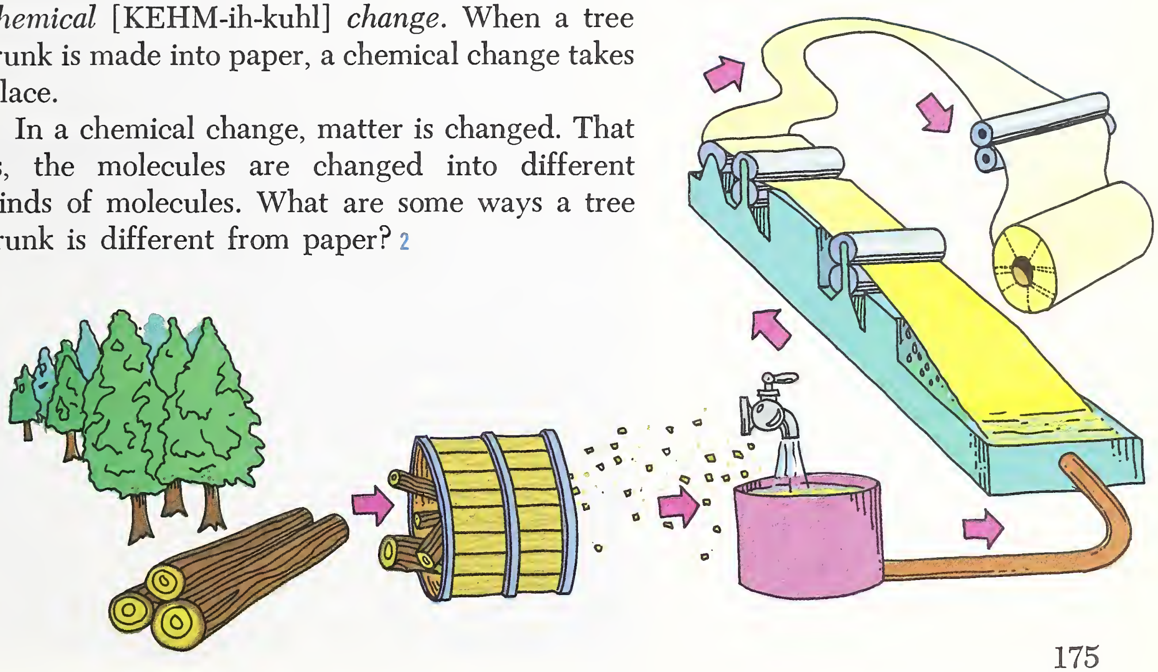
In a physical change, matter may change in the way it looks. The matter, however, does not change. That is, its molecules are not changed into different kinds of molecules. When ice melts and becomes water, the molecules do not change to other kinds of molecules. Even when water boils and becomes water vapor, there is still no change in the kind of molecules. Water molecules are still water molecules whether they are frozen or boiled. How does freezing or boiling water change the way it looks? 1

The other kind of change in matter is called a *chemical* [KEHM-ih-kuhl] *change*. When a tree trunk is made into paper, a chemical change takes place.

In a chemical change, matter is changed. That is, the molecules are changed into different kinds of molecules. What are some ways a tree trunk is different from paper? 2

[1] **Sample answer:** Frozen water looks like a solid crystal. Boiled water cannot be seen.

[2] **Sample answer:** A tree trunk is rough and hard. Paper is smooth and soft.



Main concepts of the chapter (pages 175–187):

A physical change takes place when matter changes, but the molecules do not change.

Changes in state, size, shape, and colour are physical changes.

A chemical change takes place when molecules of matter are changed into different kinds of molecules.

Some chemical changes take place during breathing, eating, rusting, burning, and cooking.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

—state the difference between a physical and chemical change;

—list and explain examples of physical and chemical changes.

Important words: physical change, chemical change, dissolve, rust, burning.

Other physical changes

Besides changes in the states of matter, there are other kinds of physical changes. Do you think it is important that things can change? Why or why not? [1]

Sizing it up. Another kind of physical change takes place when matter changes in size. Heat can make many things change in size. It can cause most of these things to become bigger.

Heat can make a sidewalk become a little bigger on a hot summer day. The same sidewalk can become a little smaller on a cold winter night. Though little, these changes in size may crack a sidewalk. What are some other things that change in size when they are heated?[2] Why do you think most matter becomes bigger when it is heated? [3]

[1] **Sample answers:** Yes. Because the world would be boring if nothing changed.

[2] **Sample answer:** Water, rubber, plastic, metal.

[3] **Sample answer:** Because the molecules begin to move faster and to take up more space when they are heated.

Kernels of popcorn have a small amount of water in them. Why does heating the popcorn make popcorn split open?

Sample answer for the caption: As the popcorn is heated, the small amount of water inside the popcorn becomes heated. The heated water will turn into a gas, take up more space, and force the corn to break apart.

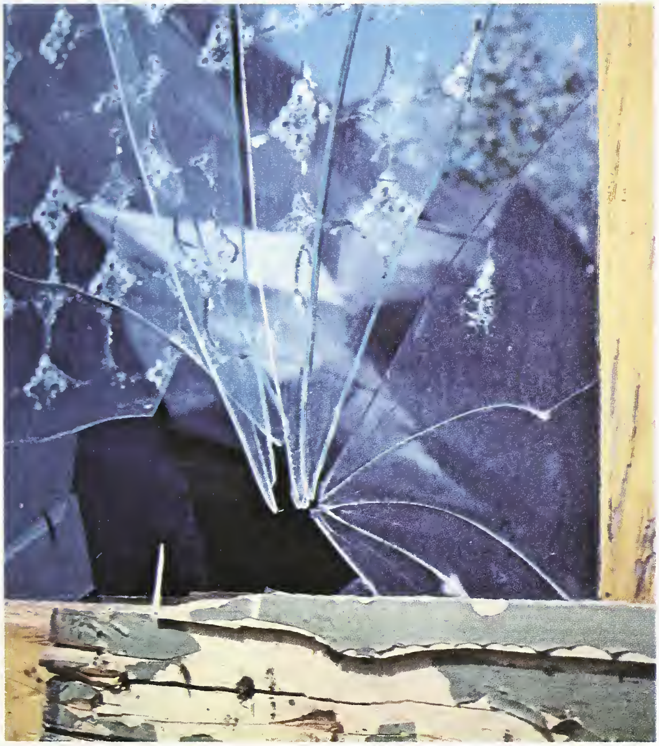
Shaping it up. A change in the shape of matter is still another kind of physical change.

When you pour milk from a bottle into a glass, the molecules of milk are not changed. The milk just changes from the shape of the bottle to the shape of the glass. What other shapes might milk take?[1]

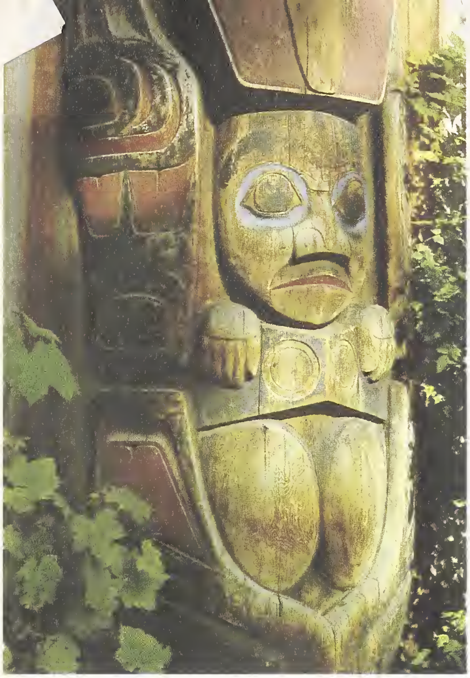
Another way in which you can change the shape of matter is by breaking it apart. The glass in a window will change shape when a ball is thrown through it. In what ways is the shape of glass in a window different after it is broken apart?[2]

[1] **Sample answer:** The shape of a cup, the stomach, or a spill.

[2] **Sample answers:** Jagged, sharp, large and small pieces.



Suggested activity: As the pupils read and discuss some of the different kinds of physical changes listed on pages 176–180, you might suggest that they find and collect pictures of some examples of these kinds of changes. A display of these pictures might be used to compare some of the ways in which people change matter.



There are many other ways in which matter can change shape. What are some things you have changed the shape of? How did you change the shape of these things?

Covering it up. Many times, a change in the colour of matter is also a kind of physical change.

If you had a blue bicycle and painted it red, you would not be changing any molecules. Your bicycle would still be your bicycle. The blue paint would just be covered up with red paint.

There are many other ways you might change the colour of matter. What are some things you have changed the colour of? What did you use to change their colour?

Mixing it up. Have you ever seen someone make a drink by mixing a powder in water or milk? If so, you have seen another kind of physical change. Many different drinks are made by adding one or two spoonfuls of a powder to a liquid. What drinks have you seen made by mixing something in water or milk?[1]

[1] **Sample answer:** Tea, coffee, cocoa, fruit drinks.

FINDING OUT

Can a solid be made to "grow" from a liquid?

You will need: 2 or 3 pieces of charcoal, 100 ml water, 100 ml laundry bluing, 100 ml table salt, 15 ml ammonia, small bowl, large plate, large bowl

- Put the pieces of charcoal in the small bowl.
- Mix the water, laundry bluing, table salt, and ammonia in the large bowl.
- Stir the mixture and pour it over the charcoal.
- Place the bowl on the large plate and put it in a place where it will not be disturbed.
- Allow it to stand for 1 or 2 days.

What changes do you see in the things in the bowl?

Teaching helps for "Finding Out":

Processes used: observing, communicating.

Sample findings: During the second day after the pupils have followed procedure, small white crystals will begin to form on the charcoal. These crystals will be very delicate and should not be touched. Each day the "growth" of these crystals will be noticeable.

Additional information: Although the new matter looks very different from the original mixture, the change is a physical one. As the liquid evaporates, the salt and ammonia crystals form in the bowl.

Extending the "Finding Out": At this time, you may wish to repeat the experiment and add food colouring to the mixture. The crystals that will grow may be any colour, depending on the number of drops of different food colouring added.

Sometimes, solids will *dissolve* [dihz-OLV], or seem to melt and disappear, when they are mixed with a liquid. When you put salt in water, the salt dissolves. How do you know that the salt molecules do not change into different molecules?[1]

[1] **Sample answer:** I can taste the salt after it is dissolved in water.

FINDING OUT

What happens to some solids and liquids when they are mixed?

You will need: salt, sand, instant tea, sugar, 4 jars, spoon

- Half fill each jar with warm water.
- Put a spoonful of a different solid in each jar.
- Stir each mixture.

How does each solid change?
Did some solids dissolve? If so, how can you tell?
Do you think the solids would act in the same way if you used different liquids?

- Try mixing your solids with oil or vinegar.

How do these mixtures differ from the water mixtures?
How does each solid act when it is put in the different liquids?

Teaching helps for "Finding Out":
Processes used: observing, comparing, collecting data, predicting.
Sample findings: The most-noticeable change is that the instant tea will dissolve quickly and change the colour of the water. The salt and sugar will also dissolve quickly, as the salt and sugar will seem to disappear. Tasting the liquid will verify the dissolving of each. The sand will settle to the bottom of the jar. The action of the solids in the other liquids will be similar to their action in the warm water.

Some chemical changes

Besides physical changes, there are many chemical changes taking place around you every day. What do you think some of these chemical changes might be?[1]

Huff and puff. There is a chemical change that is taking place in you all the time. It happens when you breathe.

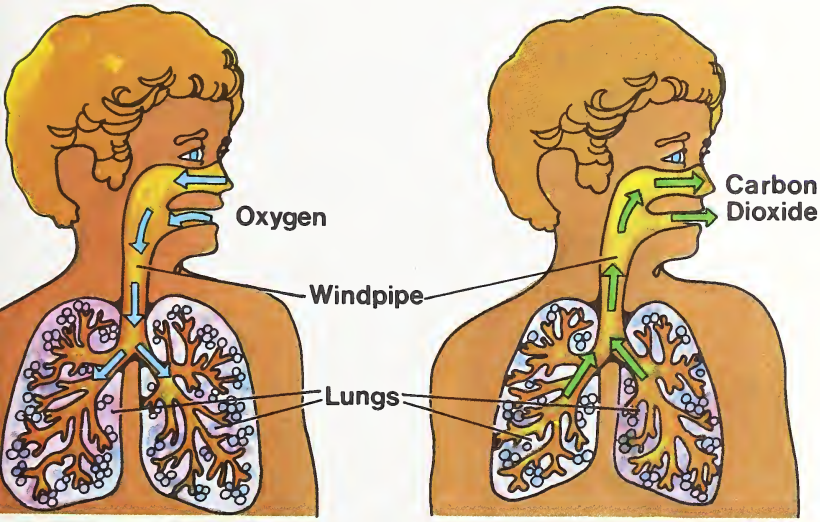
When you breathe in, you breathe in oxygen. It is used by all the parts of your body. These parts need oxygen so they can work the way they should.

As your body uses oxygen, some of the oxygen mixes with things your body no longer needs. One of these things is carbon. The oxygen and carbon join to form a gas called carbon dioxide. When you breathe out, you breathe out carbon dioxide.

Exploring on Your Own

Some matter changes because of the weather. Wind, snow, and rain are parts of weather which can change buildings, roads, and the ground. Find out how weather can change these things. Find out which changes are physical and which are chemical. What are some things around your home which have been changed by weather?

[1] **Sample answer:** Plants growing and making flowers, factories making new things, people growing and changing.



Sample findings for "Exploring on Your Own": Potholes in roads are often made when water seeps into the road and freezes. The ice forces the road to break apart. Strong winds can slowly wear away buildings and cause bricks to loosen. These are all physical changes. The acid in rainwater may sometimes eat away at bricks and roads. This would be a chemical change.

Since you and other people are breathing all the time, you may wonder why there is always enough oxygen to breathe. There is another chemical change which puts oxygen back into the air. This chemical change takes place in green plants. Green plants take in the carbon dioxide you breathe out. These plants use carbon dioxide. They need it to live and grow.

As green plants take in carbon dioxide, the carbon dioxide molecules become broken down. The carbon is used to make food for the plant. The oxygen is given off into the air.

Why do you think it is important for these chemical changes to take place?[1]

[1] **Sample answer:** So people won't run out of oxygen and plants won't run out of carbon dioxide.

A matter of taste. Think about the last time you ate a sandwich. As you chewed the sandwich, it was mixed with a liquid in your mouth. How did the sandwich change? [1]

The liquid in your mouth can change some of the food you eat. After you swallow your food, it mixes with other liquids inside your stomach and other parts of your body. These liquids also change the food you eat. They change the molecules of food into different kinds of molecules. The food you eat must be changed so that your body can use it. What are some things your body uses food for? [2]

[1] **Sample answer:** It changed shape and became more liquid. Bread (starch) changed to sugar.

Exploring on Your Own

After you eat a meal, there are many kinds of chemical changes taking place in your body. Find out what some of these chemical changes are. Using a reference book may help you. Look under the heading *digestion*.

[2] **Sample answer:** Growing, running, sleeping.

Sample findings for "Exploring on Your Own": In the mouth, the stomach, the large intestine, and the small intestine, there are different kinds of liquids called "digestive juices." As different kinds of food reach the different parts of the body, they mix with these juices. Each mixture causes a chemical change, and a new substance is made. The new substances are spread throughout the body to be "burned" by the cells. The solid, liquid, and gaseous wastes leaving the body have also been changed chemically but cannot be used by the body.

Rusting away. The chemical changes which take place during breathing and eating happen in a short time. But some chemical changes happen over a much longer time.

You may have seen an old iron fence that has started to fall apart. Or you may have seen holes near the bottoms of some cars. The iron in the fence and the cars had gone through a chemical change.

When oxygen in the air is near iron, the oxygen and the iron may join together. When iron and oxygen join, their molecules change. The molecules change to make a new kind of matter. This new matter is called *rust*.

What are some things you have seen that had rust on them? Why do you think people want to keep things from rusting?[1] What might you use to keep things from rusting?[2]

Going up in smoke. Besides rusting, there is another kind of chemical change that takes place when oxygen joins with other matter. You have most likely seen this change many times. It happens when something is *burning*. What are some things that can burn?[3]

When someone strikes a match, the match is rubbed against something. This rubbing makes enough heat for the match to burn. The molecules in the match then join with the oxygen in the air to make fire.

Fire changes molecules into different kinds of molecules. The molecules in the match and the oxygen molecules in the air change into molecules of ashes, carbon dioxide, and water.

[1] **Sample answer:** Things that are rusty fall apart and must be thrown away.

[2] **Sample answer:** Paint, cloth or plastic coverings.

[3] **Sample answer:** Paper, wood, cardboard.

Suggested research and discussion: After the pupils have read "Rusting away" and have looked at the picture of a nail on this page, you might tell them that some things are built with the intention that they rust. Some buildings and sculptures in various cities around the country are made of iron and are not protected with any covering. These things have been allowed to rust. You might have the pupils find out where some of these structures are and why they were built in this way.

There are many different things that can burn. Oil and natural gas are often burned to heat homes and other buildings. Gasoline is burned in cars and buses to make them run. What are some other ways in which burning is helpful to people?[1]

[1] **Sample answer:** Cooking food, keeping warm.

FINDING OUT

What changes can you see in a burning candle?

You will need: matches, candle, candleholder, large jar, potholder

- Place the candle in the candleholder.
- Light the candle.
- Place the jar upside down covering the candle.

What happens? Why?

- Using the potholder, remove the jar and light the candle again.

What physical changes do you see as the candle burns?
What chemical changes do you see?

- Let the candle burn down completely.

What made the candle go out this time?

Teaching helps for "Finding Out":
Processes used: observing, inferring, classifying.
Sample findings: The candle needs oxygen in order to burn. As soon as the flame uses up all the oxygen in the overturned jar, the flame will go out. As the candle burns, the physical change of the wax's melting and dripping will be evident. The chemical changes are that the wick and some of the wax will turn into carbon dioxide and water vapour. When the candle goes out the second time, it is not because of the lack of oxygen but rather the lack of fuel.

Mmmm . . . smells good! Other chemical changes you may see are the changes which take place when food is cooked.

Have you ever baked a cake? If so, you know that some of the things you put into a cake change when it is baked.

Eggs, flour, and milk are such things. How do these things look different after they are baked in a cake?[1]

There are many other chemical changes that happen when things are cooked. What are some other things you have seen cooked? How did they change?

[1] **Sample answer:** A cake does not have the colour, texture, shape, taste, or smell of either eggs, flour, or milk.

A Second Look

1. What is a physical change?
2. What is a chemical change?
3. What are some examples of physical changes?
4. What are some examples of chemical changes?

Sample answers for "A Second Look": 1. A physical change takes place when matter changes, but the molecules do not change. 2. A chemical change takes place when the molecules of matter are changed into different kinds of molecules. 3. A physical change may be a change in state, size, shape and colour. 4. A chemical change may take place during breathing, eating, rusting, burning, or cooking.

Workers Who Use Science

Many of the things around you are made by changing matter. Some of the people who study and make these changes are called *chemists* [KEHM-uhsts].

Some chemists make things for the food you eat. Fertilizers are put on crops to help them grow. Other things are put in cans and packages of food to help keep the food fresh.

Other chemists work to make many kinds of fuel. Fuels from oil are needed to heat homes and to run cars and other machines. Special fuels are made for rockets used in space travel.

Many other things used by people are also made by chemists. Matter is changed or mixed to make soap, floor wax, shampoo, hair spray, and plastic toys.

Another way in which chemists help people is by making new medicines. These medicines can help sick people become well. They can also keep people from getting certain illnesses.

To find out more about chemists, try to find answers to these questions:

What are some different kinds of chemists?[1]
What equipment do chemists need to do their work?[2]

To help you answer these questions and others you may have about chemists, you may wish to use reference books or write to the Chemical Institute of Canada, Suite 906, 151 Slater Street, Ottawa, Ontario K1P 5H3.

Sample answers for "Workers Who Use Science":

[1] Pharmacists, metallurgists.

[2] Bunsen burner, test tube, beaker, scale.

Reviewing the Main Ideas

Anything that takes up space is called matter.

All matter is made up of molecules.

Matter can be found in three states—solid, liquid, and gas.

Matter sometimes changes from one state to another.

A change of state takes place during melting, boiling, evaporation, and freezing.

A physical change takes place when matter changes, but the molecules do not change. Changes in state, size, shape, and colour are physical changes.

A chemical change takes place when molecules of matter are changed into different kinds of molecules. Some chemical changes take place during breathing, eating, rusting, burning, and cooking.

Reading About Science

Carona, Philip. *Chemistry and Cooking.* Scarborough, Ontario: Prentice-Hall of Canada Ltd., 1975.
Haines, Gail Kay. *The Elements.* Toronto, Ontario: Grolier Limited, 1972.
Lefkowitz, R.J. *Matter All Around You: A Book About Solids, Liquids & Gases.* Scarborough, Ontario: McGraw-Hill Ryerson Limited, 1972.
Shalit, Nathan. *Cup and Saucer Chemistry.* Scarborough, Ontario: Grosset & Dunlap, Inc., 1974.
Trueman, R.H. *Simple Solutions.* Toronto, Ontario: Macmillan Company of Canada Ltd., 1975.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 190.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to the topics of solids, liquids, and gases. Such articles might be found in reference books under the headings *molecules, heat,* and *water.*

Testing for Understanding

Ideas to Check

On your paper, write *T* for each sentence below that is true. Write *F* for each sentence that is false.

T 1. All matter takes up space.
F 2. Liquids have a shape of their own.
T 3. Matter may be in one of three states.
F 4. There are no molecules in the air around you.
T 5. A physical change may be a change of shape or colour.
T 6. Freezing is a physical change.
T 7. Burning is a chemical change.
F 8. Molecules are packed tightly together in a gas.
F 9. Gases have a shape of their own.

Words to Use

Write on your paper the word or words that best fit in each blank below. Choose from these words: *gas, states of matter, solid, chemical, molecules, physical, liquid, water vapour, oxygen, dissolve.*

1. All matter is made of ____. molecules
2. When a solid melts, it changes into a ____. liquid
3. When water changes to a gas, it is called ____. water vapour
4. In a ____ change, molecules of matter are changed into different kinds of molecules. chemical
5. Changing ice to water is a ____ change. physical
6. Solids, liquids, and gases are known as ____. states of matter
7. Rust is made when iron joins with ____. oxygen
8. Some solids ____ when they are mixed in a liquid. dissolve

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Solids, Liquids, and Gases" are provided for you on page T19 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22 of the Teacher's Manual.

Having Fun with Science

Word-clue Game

Read the clues. On a sheet of paper, fill in the letters of the word that fit in each space.

matter	M – – – – –	anything that takes up space
solid	– O – – –	a state of matter
cloud	– L – – –	water in the sky
evaporation	E – – – – – – – – – –	liquid to a gas
chemical	C – – – – – – –	a kind of change in matter
liquid	– – – U – –	a state of matter
physical	– – – – – – – L	a kind of change in matter
melting	– E – – – – –	solid to a liquid
gas	– – S	a state of matter

Make up a word-clue game of your own about matter!

Magic Show

Pretend you are a magician. You are asked to make these things "disappear": salt, a candy bar, an iron bar, a puddle, an ice cube, a dime, and a piece of paper. What changes might make these things "disappear"?

Guess the Matter Yes or No?

Play a guessing game with a group of people. Have one person think of a kind of matter. Have others try to guess what it is by asking yes-no questions such as these: Does it have a shape? Can it be seen? Can it boil? Can it dissolve? Can it burn?

Sample answers for "Magic Show":
dissolve salt in water
eat the candy bar
allow the iron bar to turn to rust
let the puddle evaporate
melt the ice cube
melt the dime
burn the paper

For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of the unit "Solids, Liquids, and Gases." You may also wish to encourage the pupils to make up additional activities related to the topics of the states of matter and their physical and chemical changes.

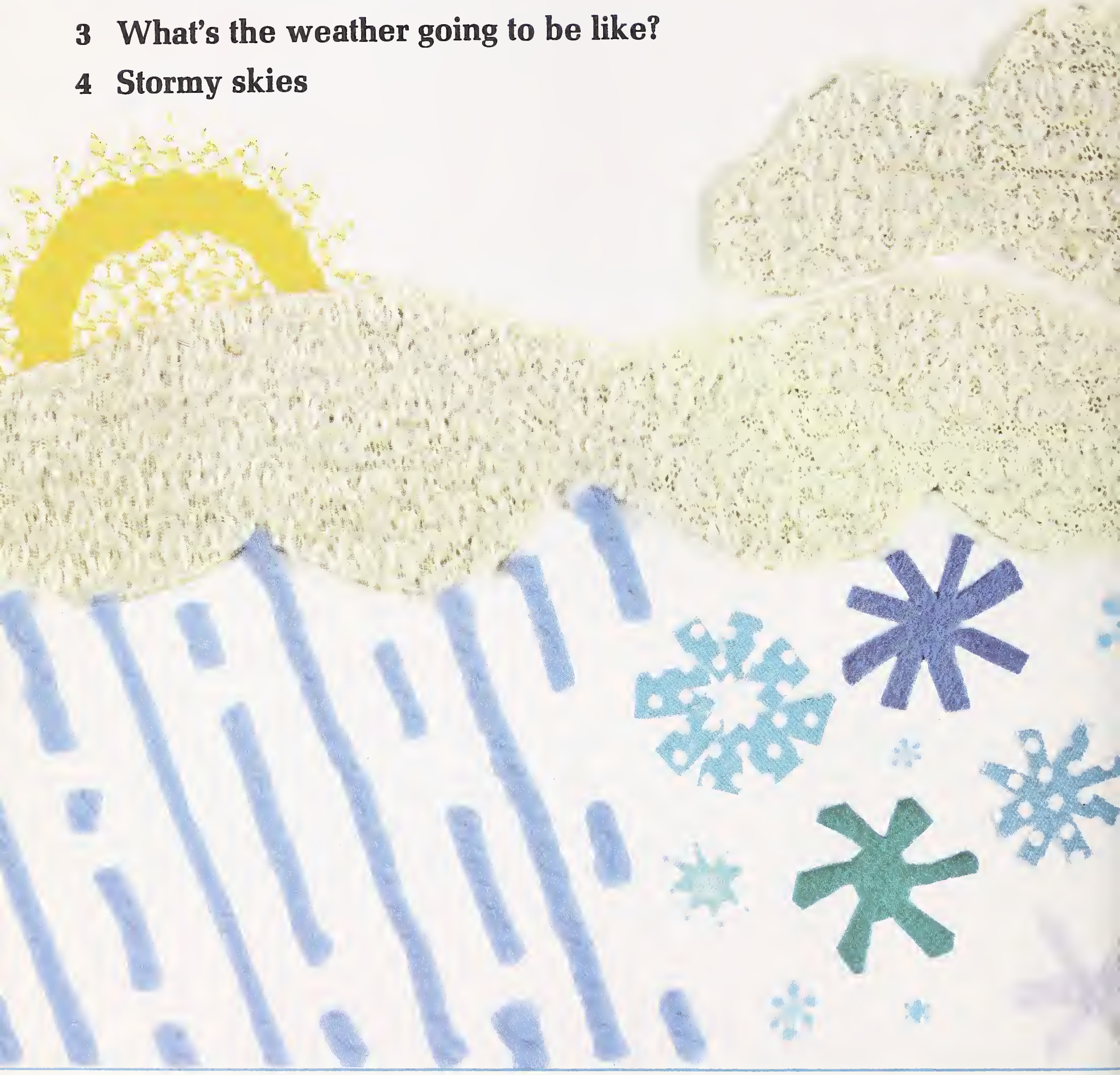
5 Air and Weather

1 The air around you

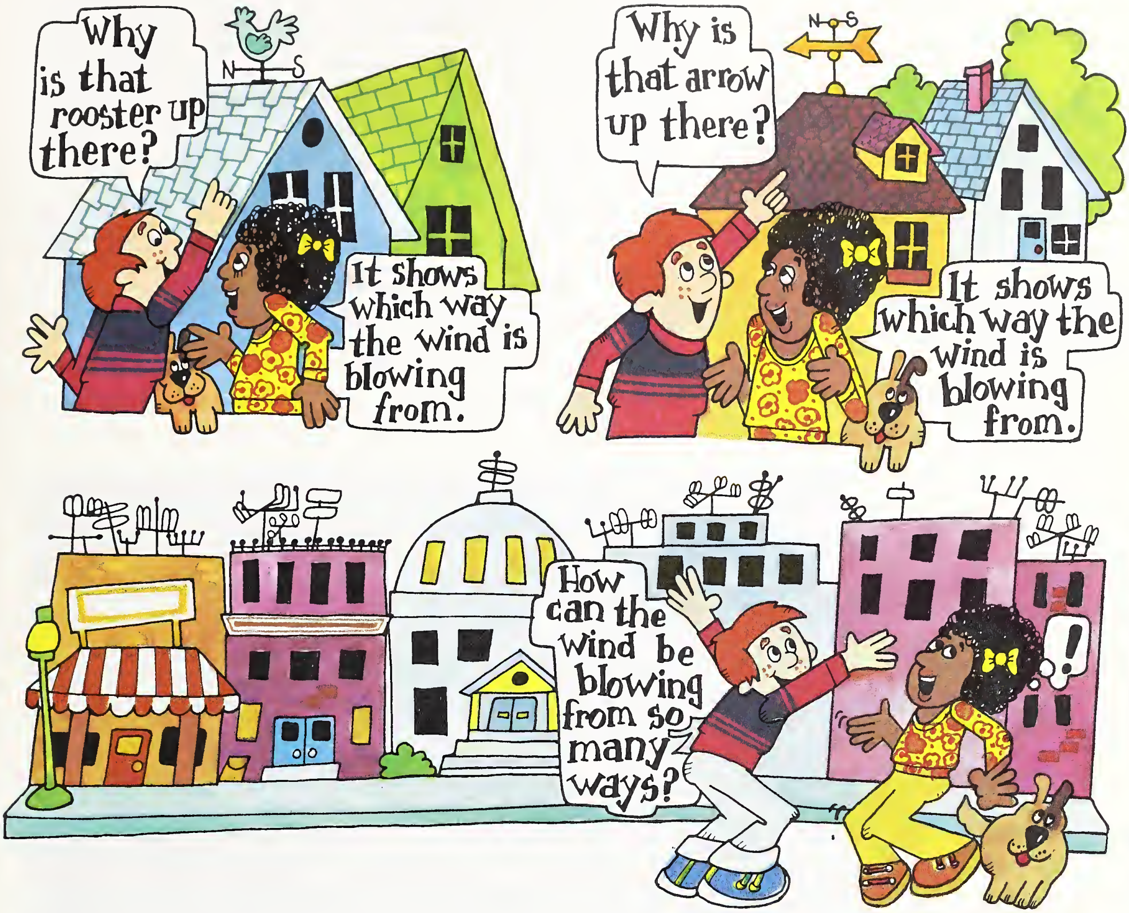
2 What makes up weather?

3 What's the weather going to be like?

4 Stormy skies



Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see page T14 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit and have the pupils begin collecting these materials. These activities are found on pages 195, 197, 199, 204, 210, 220, and 226.


Why is that rooster up there?
N
S
It shows which way the wind is blowing from.
Why is that arrow up there?
N
S
It shows which way the wind is blowing from.
How can the wind be blowing from so many ways?
!

What is wind?[1]

When is it helpful for you to know which way the wind is blowing from?[2]

What do you think wind has to do with weather?[3]

Introducing the unit: You may wish to have the pupils read the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:

[1] Wind is moving air.

[2] Sailing a boat, flying a kite, protecting the eyes from dirt in the wind.

[3] The wind can blow storms to different areas.

1 The air around you

Stop for a moment. Wave your hand in front of you. It may seem as if there is nothing in front of you except your hand. But something else is there, too. It's the thing you need most each day. It's the *air* around you. You must breathe air in order to live. What other living things need air? [1]

Air is important to you in another way. Look outside. What are some of the things that make up the *weather* you are having today? Do you see rain? Snow? What else makes up weather? [2]

[1] **Sample answer:** Plants, animals.

[2] **Sample answer:** Wind, sleet, hail, sunlight, clouds.

Main concepts of the chapter (pages 194–200):

Air is an important part of weather.

The air around you is made up of many things. Gas, smoke, and dust are some of these things.

Moist air weighs less than dry air.

Air pressure is caused by the weight of the air pressing down on things.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

—demonstrate that air takes up space;
—name the things which make up the air;
—state that air has weight;
—explain what is meant by air pressure.

Important words: air, weather, space, nitrogen, oxygen, water vapour, gravity, air pressure.

Whatever your answers are, all these things have to do with the way the air is. So, to understand some things about weather, you need to know some things about air. In what ways is weather important to you?[1]

[1] **Sample answer:** Many of the things I do and the way I feel sometimes depend on the weather.

How can you tell it's there?

You cannot see air. But you can feel it. You can feel it as it blows around you. You can feel it because it takes up *space*, or room. It takes up space just as books, buildings, and you do.

Picture a circle drawn around the earth about

FINDING OUT

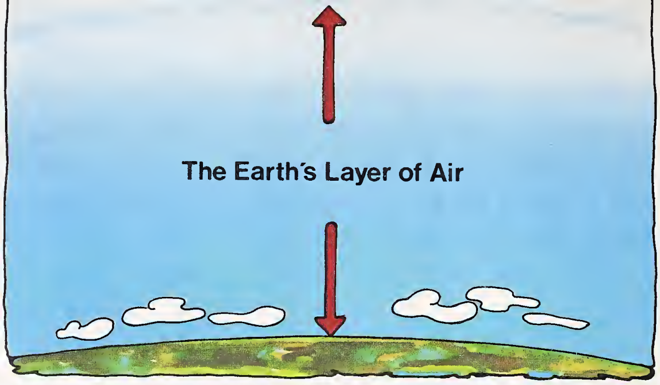
How can you do a "trick" with air?

You will need: handkerchief, drinking glass, pot of water

- Stuff the handkerchief into the glass as shown.
- Place the glass upside down into the pot of water.
- Remove the glass from the water.

Is the handkerchief wet or dry? Why?

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: After the glass has been removed from the water, the handkerchief inside the glass will be dry. Since air takes up space in the glass, there is no room for the water to get inside and wet the handkerchief.



eight hundred *kilometres* above the earth. From the ground to this circle is where most of the air on the earth is. What do you think it would be like if you were to go outside this circle? Why?[1]

What makes up air?

Many things make up air. But as you know, you are not able to see some of these things. This is because they are gases. One such gas is *nitrogen* [NY-truh-juhn]. *Oxygen* [OK-sih-juhn] is another. Why is oxygen important to you?[2]

There is water in air, too. It is called *water vapour*. Water vapour is a gas. Steam from boiling water may seem to disappear. But it really turns into water vapour. How else might water vapour get into the air?[3]

Sometimes you can see some of the things which make up air. Smoke and dust are such things. When have you seen these things in the air?[4]

[1] **Sample answers:** I couldn't breathe. Because there is not enough air.

[2] **Sample answer:** I need oxygen to breathe in order to live.

[3] **Sample answer:** Water evaporates from oceans, lakes, and rivers.

[4] **Sample answer:** Exhaust from cars, smoke from factory smokestacks, dust stirred up by wind.

Exploring on Your Own

People who have trouble breathing are sometimes given pure oxygen to breathe. Find out why this is so. You might want to talk to your school nurse or a doctor.

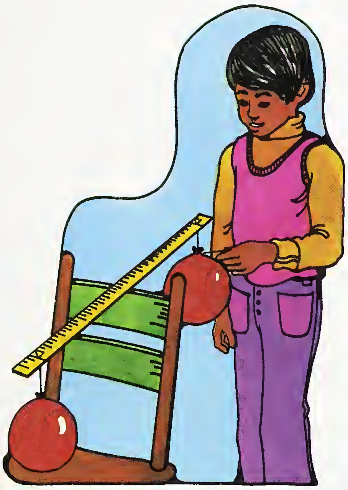
Sample findings for "Exploring on Your Own": When a person breathes in normal air, the intake is about 20% of the needed oxygen. The remaining 80% is a combination of other gases and pollutants. When a person has difficulty breathing, pure oxygen is given to make sure the person gets enough oxygen in order to live. The other things in the air are not needed by the body.

Can you weigh air?

You can feel air, but does it have weight? It may be hard to believe that something you can't see has weight. The force of gravity pulls things toward the earth. This is what gives things their weight. Every time you step on a scale, you find out how much the force of gravity is pulling on you. Gravity pulls down on air, too. So, air has weight.

But air doesn't weigh the same. Moist air weighs less than dry air. This is because moist air has a lot of water vapour in it. And water vapour weighs less than other gases in the air. Have you ever felt water vapour in the air? If so, when?[1]

[1] **Sample answers:** Yes. When water is boiling or after a shower when the windows are all steamed up.



FINDING OUT

How can you show that air has weight?

You will need: 2 balloons, string, metre stick, pin

- Blow up the balloons so that they are as equal in size as possible. Tie each one shut with a string.
- Tie the balloons to the ends of the metre stick.
- Balance the metre stick as shown.
- Let air escape slowly from one balloon by pricking it with the pin just below the knot as shown.

Teaching helps for "Finding Out":
Processes used: comparing, observing, inferring.
Sample findings: The metre stick will begin to tip and lose its balance. The balloon with the leaking air will rise because the weight of the other balloon with the air still inside it will be greater.

What is air pressure?

Because air has weight, it presses down on things. This pressing down of air is called *air pressure*. Look at the boy in the picture on this page. He is finding out something about air pressure. As he sucks on the straw, he is sucking the air out of the straw. There is now less air pressure in the straw. But the air pressure on the juice outside the straw has not been changed. So the air pressure on the juice is greater than in the straw. The greater air pressure on the juice pushes some of it up into the straw and into the boy's mouth. What would happen to the juice if he stopped sucking? Why?[1]

[1] **Sample answers:** The juice would go down the straw to the level in the glass. The air pressure would force the juice down.

Suggested activity: After the pupils read the text on page 198 about "What is air pressure?" you may wish to explain and demonstrate a siphon. Siphons use the force of air pressure to remove a liquid from a container. Common uses of siphons are taking water out of a fish tank, taking gasoline out of a car's gas tank, or removing water from a clogged sink. To demonstrate a siphon you need a narrow hose and a bucket. If you wish to remove water from a fish tank on a table, place the bucket on the floor and put one end of the hose in the tank. Begin the flow of water by suction, and the air pressure will continue to take the water up and out of the tank.

FINDING OUT

How can you show that air has pressure?

You will need: empty can with screw top, hot plate or burner, gloves or mittens, pan of cold water

- Put about 125 ml of water into the can.
- Heat the can until steam flows freely out of the top. Caution: do not heat the can with the top on.
- Put the gloves on and remove the can from the heat. Screw the top on tightly.
- Put the can in the pan of cold water.

What happens to the can? Why?

Air is pressing down on you, too. You do not usually feel this pressure. This is because there is air inside you. And it is pressing outward. Air pressure outside your body and air pressure inside your body are equal.

There are times, however, when you might feel air pressure. Have you ever felt a "pop" in your ears? If so, it might have been when you rode up or down in an elevator. As you ride up, the air pressure outside your ears is less than that inside your ears. As you ride down, the air pressure outside your ears is greater than that inside your ears. The difference in air pressure is what

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: After the can has been placed in a pan of cold water, the can will crush. This happens because the air pressure outside the can is greater than inside the can.
Additional information: When the water was heated and steam flowed out of the can, most of the air was pushed out. The cold water caused the steam inside the can to condense causing the air pressure inside the can to drop considerably. This forced in the sides of the can.
Extending the "Finding Out": After the pupils have seen the can crushed by the pressure of air, you might have them find out how much pressure was needed to crush the can. Using a can identical to the one in the experiment, the pupils might press on the can to find out how hard they must press to get the same results.

causes the pop in your ears. Why do you think the air pressure changes when you ride in an elevator?[1]

For You to Think About

Airline pilots must make sure that the air pressure inside an airplane is about the same as the air pressure close to the ground below. Why do you think this is important?

[1] **Sample answer:** There is less air pressure at the higher floors of a building. When the elevator goes up, there is less pressure. When it goes down, there is more pressure.

A Second Look

1. In what ways is air important to you?
2. What are some things that make up air?
3. What is air pressure?

Sample answer for "For You to Think About": People are used to a certain amount of air pressure for breathing. If the same air pressure is not kept up in a plane, people will have a hard time breathing. They also will feel pressure in their head and a "popping" in the ears.

Sample answers for "A Second Look": 1. Air is important for breathing in order to live, and air is what makes up the weather. 2. Nitrogen, oxygen, water vapour, smoke, and dust. 3. Air pressure is the weight of the air pressing down on all things.

2 What makes up weather?

Here is a riddle for you! See if you can think of what "it" is.

Sometimes it stands still;
  sometimes it moves.
Sometimes you can feel it;
  sometimes you cannot feel it.
It can be warm;
  it can be cold.
You cannot see it,
  but it is all around you.
It is worth more than money to you,
  but it costs nothing.

If you think the answer to the riddle is air, you are right! And some of the clues in the riddle are about the ways in which air changes. What are some of these changes?[1] What do you think they have to do with weather?[2]

[1] **Sample answer:** It moves and then becomes still. It is warm and then cold.

[2] **Sample answer:** Since air changes, weather changes.

Main concepts of the chapter (pages 201–211):
Air can change in many ways.
When air is warmed, it takes up more space than when it is cooled.
A thermometer can be used to find out the temperature of the air.
The movement of warm air and cold air is what makes wind.
When water evaporates, the water changes into water vapour.
Clouds are made when dust and water vapour are mixed and cooled.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—name some ways in which air can change;
—explain what causes wind;
—describe how clouds are made.

Important words: temperature, thermometer, wind, evaporated, humidity.

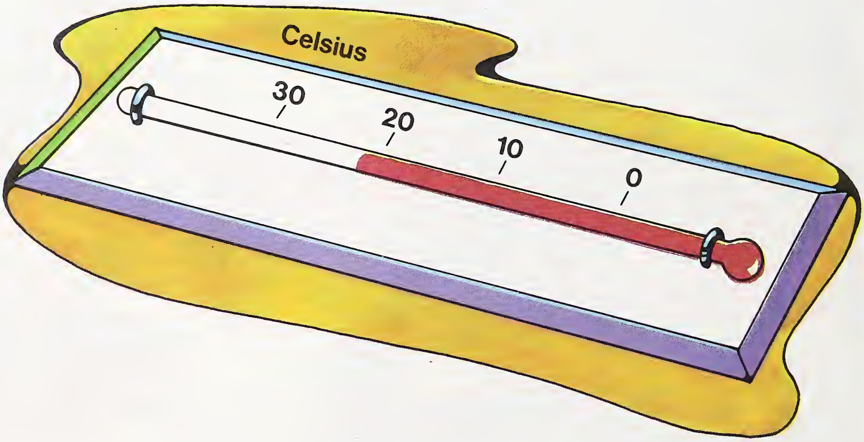
How warm or how cool?

Have you ever had your *temperature* taken? If so, it might have been when you were sick. Someone wanted to see if you had a fever. That person used a *thermometer* [thuh(r)-MOM-uht-ur]. It is used to find out the temperature of your body. That is, it shows how warm your body is.

A thermometer can also be used to find out the temperature of the air. A thermometer is marked with lines. These lines show degrees. When the air is warm, the liquid inside a thermometer rises. When the air is cool, the liquid falls.

Look at the thermometer pictured below. It shows that the temperature of the air is 21°C. This means that the air is not too hot. And it is not too cold. When the temperature of the air is about 0°C, the air is cold. Water outside may freeze. What do you think the temperature might be on a hot day?[1]

[1] **Sample answer:** 30°C.



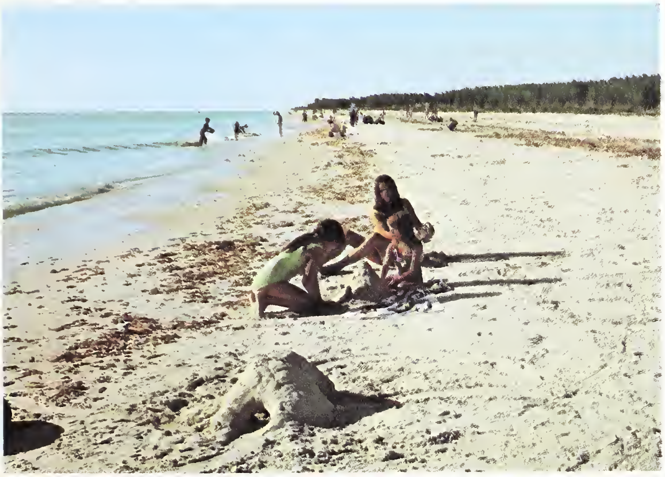
Suggested activity: After the pupils read about thermometers on this page, you might have them draw different thermometers they have seen. You might have them fill in their thermometers to show the temperature of some places around the world.

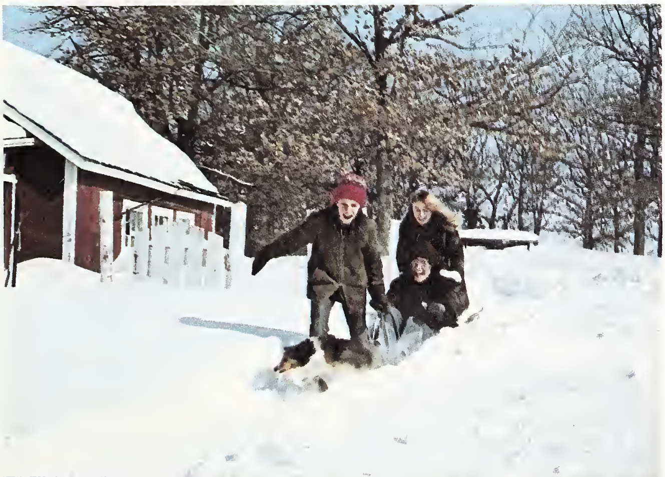
Look at the pictures below. These children live on two different parts of the earth. They are playing outside on a January day. What makes the weather in each place so different?[1]

As you may know, the sun heats the air and land around you. In some places, the sun shines directly on the land. But in other places, the sun shines at a slant. Which place would get more of the sun's heat? Why?[2]

Exploring on Your Own

For about five days, look in the newspaper and make a record of the weather in your town or city. Compare the temperatures of your town or city with those of other parts of Canada. What places have the highest temperatures? What places have the lowest temperatures? Why do you think this is so?

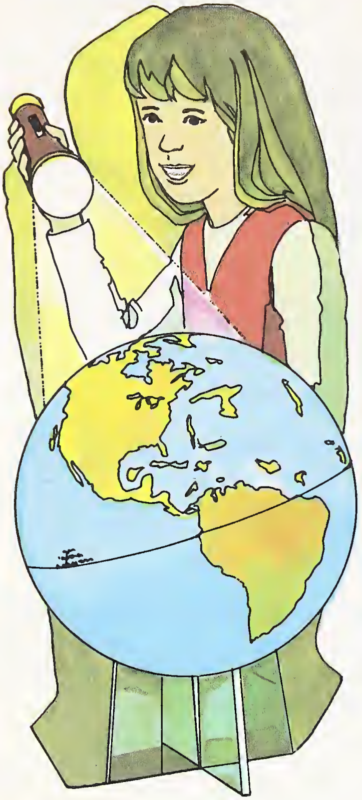




[1] **Sample answer:** Above, the weather is warm because there is more heat from the sun. Below, the weather is cold because there is less heat from the sun.

[2] **Sample answers:** Places where the sun shines directly. Because more of the sun's rays strike on the land when sunlight is direct.

Sample findings for "Exploring on Your Own": Generally, the parts of the country south of your town or city will most likely be warmer. The parts of the country north will most likely be cooler. The farther north on the earth, the greater the slant of the sun. However, elevations and closeness to oceans or lakes will also affect the temperature of places.



FINDING OUT

How can you show why some places on earth get more of the sun's heat than other places?

You will need: flashlight, globe of the world

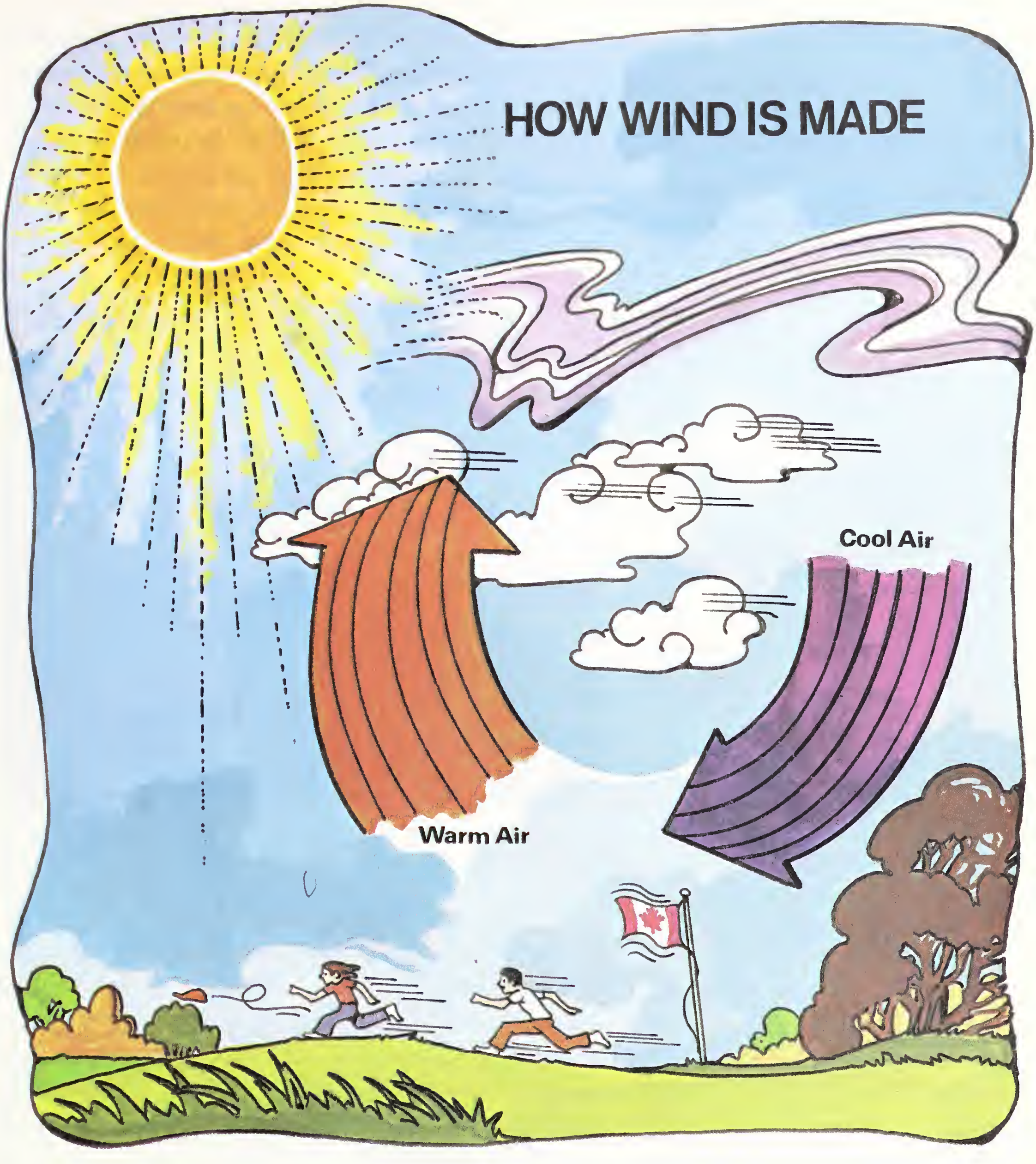
- Turn off the lights and pull the shades down to darken the room.
- Shine the flashlight directly at a place on the globe as shown. (The flashlight may be thought of as the sun.)
- Shine the "sun" at an angle at another place on the globe.

Which of the places on the globe receives more "sunlight"? Why? Which of the places do you think gets more heat? Why?

The windy part of weather

When air is warmed by the sun, the air becomes lighter. This lighter air rises. It is pushed up by colder, heavier air. This moving of warm and cold air is what makes wind. The picture on the next page shows how this happens.

Teaching helps for "Finding Out":
Processes used: observing, inferring, comparing. *Sample findings:* The flashlight will be able to light up only one half the globe. The area of the globe directly under the light will receive the greatest amount of light. The areas which receive the most light will also get more heat. The light and heat from the sun hit the areas on the globe which are closest to the sun.


HOW WIND IS MADE
Cool Air
Warm Air

Most winds are helpful. They might help cool you on a hot day. They might help you fly a kite. There are some other ways winds might be helpful. What might they be?[1] In what ways might winds be harmful?[2]

During the winter, in some parts of Canada, weather reporters talk about the "windchill." Strong winds can sometimes make you feel colder than you expect from what the thermometer shows. This is because your body loses heat faster as the wind blows more strongly. When might you need to know if there is a windchill?[1]

[1] **Sample answer:** Sailing a boat, gliding, drying clothes on a line.

[2] **Sample answer:** Strong winds can blow down trees and overturn boats.

[3] **Sample answer:** Before spending a long time outside on a very cold day.

Suggested discussion: After the pupils study the first paragraph on this page, you might promote a class discussion based on these questions: What experiences have you had on a windy day? When might the wind cause funny things to happen? What extra precautions must you take on a windy day? (Sample answers: Because the wind can cause things to be blown away, people must hold some things tightly in their hands. Things which are normally left out in the open must be secured in place.)

The wet part of weather

As you read, air has water vapour in it. But how do you think this water vapour gets into the air?[1] And how might it affect the weather?[2]

Have you ever walked to school in the rain? If so, you may have seen puddles of water everywhere. Later that same day, the sun may have come out. And the puddles were gone! The puddles of water had *evaporated* [ih-VAP-uh-RAYT-uhd]. When water evaporates, it changes to water vapour. Why do you think the sun causes water to evaporate?[3]

[1] **Sample answer:** The water on the earth evaporates into the air.

[2] **Sample answer:** Water vapour in the air may cause fog, dew, or rain.

[3] **Sample answer:** The sun's heat causes the water to become so warm that it changes to water vapour.

Suggested activity: After the pupils have read and discussed the material on this page, you might have them do the following activity. Fill about five small glasses of water halfway. Place each glass in a different place. Such places might be on a windowsill, outdoors, in a closet. Then have them check on the evaporation time for each glass of water. Have them compare the evaporation time and discuss why some water evaporates faster than other water.

As water vapour forms, it rises. As it rises, it becomes cooled. It then mixes with dust in the air to form small droplets of water. These water droplets make up clouds.

Sometimes the air becomes still colder after a cloud has been made. Then more and more little droplets of water will gather in the cloud. Soon the cloud can no longer hold any more water. Then the droplets will begin to fall. It is raining! Sometimes the temperature is below freezing. What might happen then? [1]

You may sometimes hear weather reporters talk about the *humidity* [hyoo-MIHD-uht-ee] in the air. Humidity is the amount of water vapour in the air. When the humidity is high, you may feel warm and "sticky." When it is low, you may feel cool and dry. Weather reporters talk about the humidity more often during summer than any other time. Why? [2]

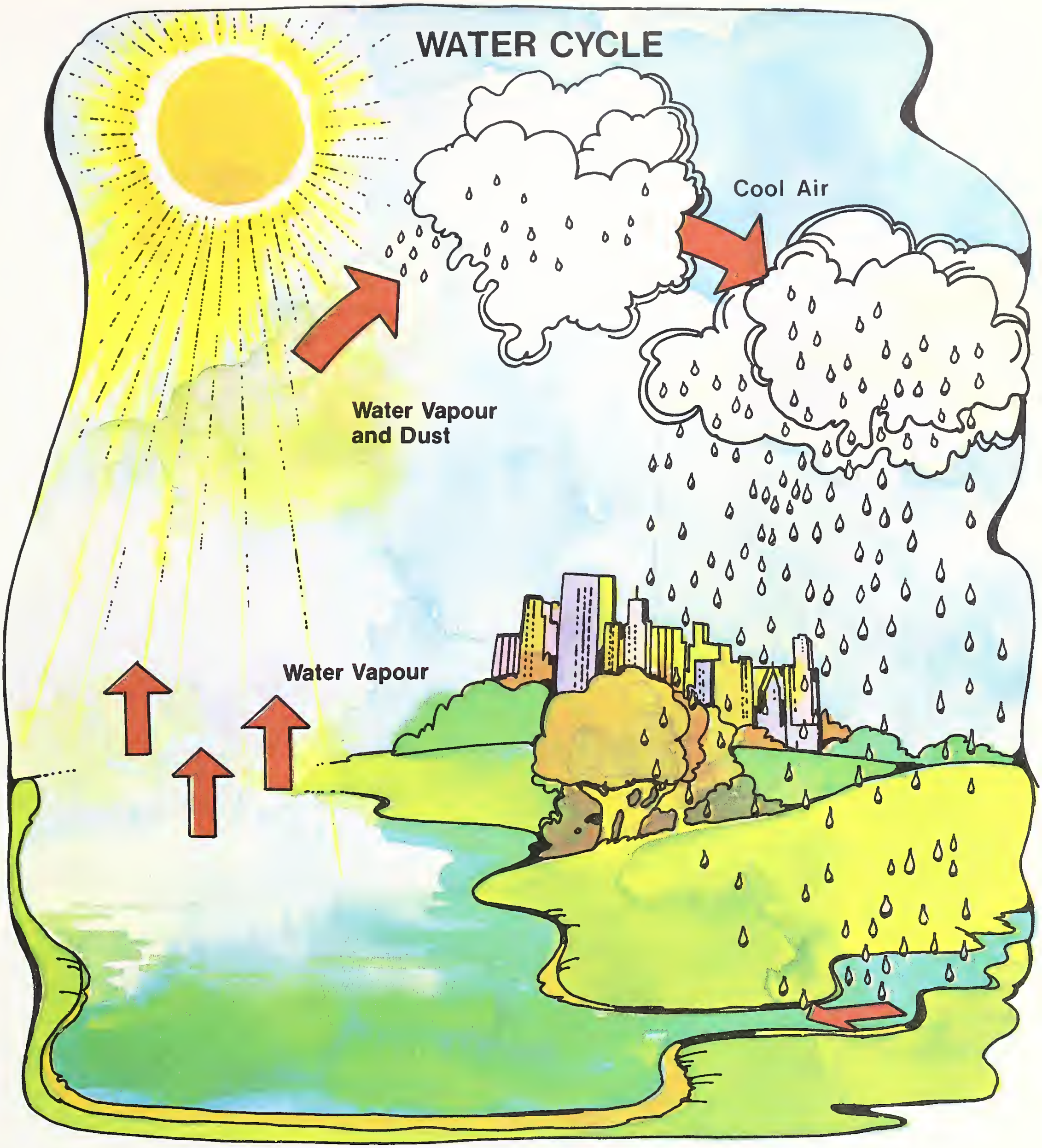
[1] **Sample answer:** Snow, hail, or sleet may fall.

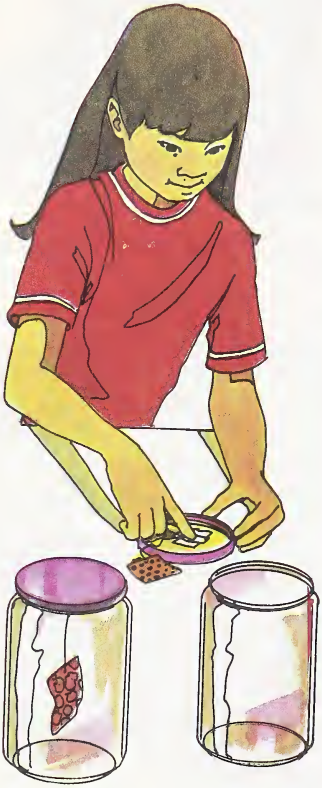
Exploring on Your Own

Some people live in parts of Canada where the air is dry. Dry air is easier to breathe than moist air. Find out why this is so. What are some parts of Canada that have dry air?

[2] **Sample answer:** High humidity on a warm day can make the air feel warmer than it really is.

Sample findings for "Exploring on Your Own": Moist air is harder to breathe because of the large amount of water vapour taking up space in the trachea and lungs. The dry air allows more space in these areas for oxygen. The dry areas in Canada are the southern Okanagan Valley in British Columbia, and parts of Saskatchewan, Alberta and Manitoba.


WATER CYCLE
Cool Air
Water Vapour
and Dust
Water Vapour



FINDING OUT

Which holds more water vapour, warm air or cold air?

You will need: 2 jars of the same size, screw covers for these jars, 2 pieces of cotton cloth about six square centimetres, needle, thread, tape

- Place one of the jars in sunlight or on a hot radiator for about an hour. Do not put the top on the jar. Place the other jar in the refrigerator for an hour. Do not put the top on that jar.
- Wet both pieces of cloth. Squeeze out any of the extra water.
- Remove the jars from the cold and heat.
- Using the needle, thread, and tape, put the cloths on the bottom of the lids as shown.
- Screw on the lids.
- Put the warm jar back into the sunlight or on a radiator. Put the other jar back into the refrigerator.
- After an hour, check the cloths.

Is one cloth drier than the other? If so, why?

Air pressure and weather

You may hear about another thing in a weather report. It is air pressure. When air is warmed, it takes up more space. Then there is less air in a given place. So, the air pressure is

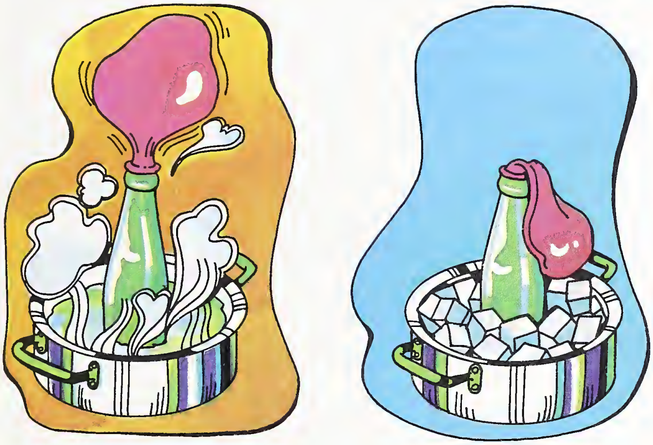
Teaching helps for "Finding Out":
Processes used: comparing, observing, inferring.
Sample findings: The cloth that was in the cold jar in the refrigerator will be wetter than the cloth in the warm jar. Warm air holds more water vapour than cold air.

Extending the "Finding Out": At this time, you might have the pupils find out about machines which control the humidity in the air. Many people have humidifiers and dehumidifiers in their home. Have the pupils find out what these machines do, how they work, and when they are used.

lower. When low-pressure air comes your way, it often brings warm, cloudy weather.

When air is cooled, it takes up less space. Then there is more air in a given place. So, the air pressure is higher. When high-pressure air comes your way, it often brings clear, cooler weather.

Besides changes in air pressure, what are some other things that might help tell what the weather is going to be like?[1]



Each of these bottles with a balloon contains the same amount of air. Why do you think one balloon is bigger than the other?

A Second Look

1. How does the sun cause temperatures to differ on different parts of the earth?
2. How are winds made?
3. How are clouds made?
4. How might air pressure affect the weather?

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[1] **Sample answer:** Clouds, temperature changes, "ring" around the moon, colour of the sunset, direction of the wind.

Sample answers for the caption: The bottle in the pan of hot water is filled with heated air. The heated air takes up more space and inflates the balloon. The bottle in the pan with ice cubes is filled with very cold air. The cold air takes up less space and deflates the balloon.

Sample Answers for "A Second Look": 1. The sun shines more directly on some areas of the earth than on others. The areas getting the more direct sunlight have higher temperatures than other areas. 2. When air is heated by the sun, it becomes lighter and will rise. This warm air is replaced by the colder, heavier air. The moving of the warm and cold air makes wind. 3. Water vapour in the air mixes with dust in the air to form tiny drops of water. These droplets of water come together to form clouds. 4. Low-pressure air often brings warm, cloudy weather. High-pressure air often brings clear, cool weather.

3 What's the weather going to be like?

Knowing what the weather is going to be like is important to many people. Some of them have jobs that are affected by the weather. Airplane pilots and farmers are such people. There are times when you might want to know what the weather will be. When are some of those times?[1]

[1] **Sample answer:** When planning a trip or an outside activity.

This meteorologist is using maps to prepare her forecast. How might these maps be helpful to her?

A job with weather

There are many people who study weather. Some of these people are called *meteorologists* [MEET-ee-uh-ROL-uh-juhsts]. These people try to *forecast* the weather. That is, they try to tell what the weather will be like. To help them do this, they use many *instruments* [IHN(T)-struh-muhnts]. These instruments measure things about the weather in their town.

Main concepts of the chapter (pages 212–224):

Meteorologists are people who study weather and make weather forecasts.

Meteorologists use many kinds of instruments to help them predict the weather.

Certain kinds of clouds can show what kind of weather might be coming.

Seeding clouds is a way of making rain.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

—explain how meteorologists predict the weather;

—name four kinds of clouds and tell how they can help predict the weather.

Important words: meteorologists, forecast, instruments, dry-bulb thermometer, wet-bulb thermometer, rain gauge, radar antenna, barometer, cumulus, nimbus, stratus, cirrus, chemicals.

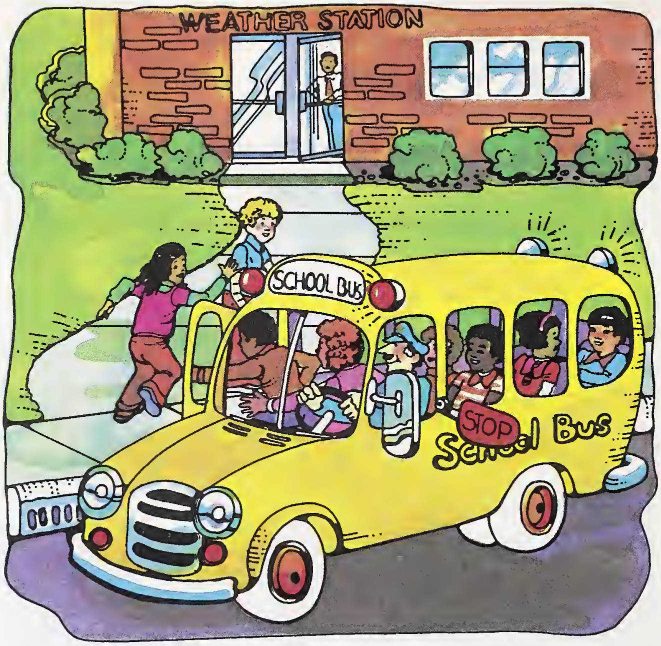
In order for meteorologists to forecast weather, they must also find out about the weather in other parts of North America. They get reports from weather stations in other towns. They also get information from weather balloons and satellites.

Meteorologists do their best to forecast the weather. But there are times when they might forecast a sunny day and it rains. This may be because weather sometimes changes very fast. Then, even meteorologists have a hard time keeping track of it!

This meteorologist is using a special screen to help keep track of storms in the area. Why is it important to keep track of storms?

Sample answer for the caption on page 212: She is able to show the weather in the entire country. In this way, people will know about the weather in their area, as well as the weather that is soon to come. Also, if people are planning a trip, they will know what weather to expect.

Sample answer for the caption on this page: If the storm is bad, meteorologists warn people of possible danger. Also, meteorologists give storm information for sailors out at sea and pilots in the upper atmosphere.



Putting it together

The place where most meteorologists work is called a weather station. Suppose you visited a weather station. You would meet some of the meteorologists who work there. One of them asks if you would like to see how a weather forecast is put together. And you say Yes!

One place that the meteorologist takes you is the roof of the station. Up there you see some weather instruments. You can hardly believe your eyes as you look around you. There are so many instruments! But soon the meteorologist begins to tell you how each one works.

For You to Think About

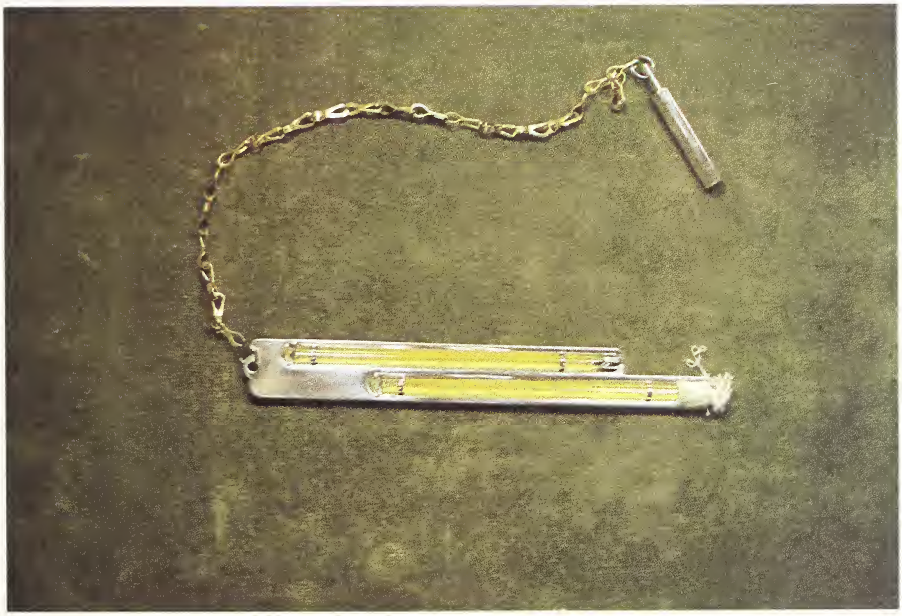
Many weather stations are located at airports. Do you think this is a good idea? Why or why not?

Sample answers for "For You to Think About": Yes. Because weather information is important to aircraft pilots at the airport.

Wet or dry? The first instrument you see has two thermometers. One of the thermometers is called a *dry-bulb thermometer*. The other thermometer is called a *wet-bulb thermometer*. This is because a wet "sock" is kept around the bulb.

The meteorologist first checks the temperature of the dry-bulb thermometer. Then the instrument is twirled around in the air. After two minutes, the temperature of the wet-bulb thermometer is checked. The meteorologist wants to find out how much water has evaporated from the sock. This is done by seeing how far the temperature has fallen. Then the meteorologist compares both temperatures. After doing this, the humidity of the air can be learned. Why do you think the wet sock makes the temperature of the thermometer fall? [1]

[1] **Sample answer:** Because the water on the sock evaporates. Evaporation causes the temperature to drop.



Suggested activity: To show the cooling process of evaporation best, you might fill a glass with rubbing alcohol halfway. Place a thermometer in the alcohol. Since alcohol evaporates very quickly, the pupils will be able to watch the temperature drop rapidly. The pupils might also put a few drops of alcohol on their hands to feel the coolness of evaporation.

How much rain? Next, the meteorologist shows you a *rain gauge* [GAYJ]. As rain falls, it goes into a funnel and then into a tube. The meteorologist then uses a special ruler. This ruler shows how much rain is inside the tube. Why do you think meteorologists want to know how much rain has fallen?[1]

Which way? The meteorologist also shows you a weather vane. Its head points to the way the wind is blowing from. Why do meteorologists need to know which way the wind is blowing from?[2] Who are some other people who might want to know this? Why?[3]

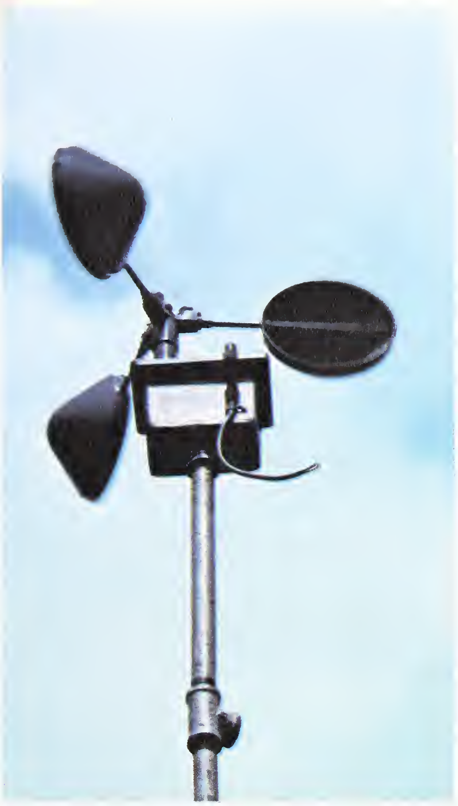
[1] **Sample answer:** So they can report to people about possible flooding.

[2] **Sample answer:** So they would be able to know which kind of weather might be coming their way.

[3] **Sample answers:** Sailors; to help them in their travels. Pilots; to help them take off, land, and fly their planes. Kite fliers; to help them get their kite in the air.

Suggested activity: After the pupils have read "Which way?" you might have them make weather vanes. A reference book might help them discover the basics of a weather vane. Have your pupils use their weather vanes to find the wind direction on various days.

Weather Vane



Anemometer

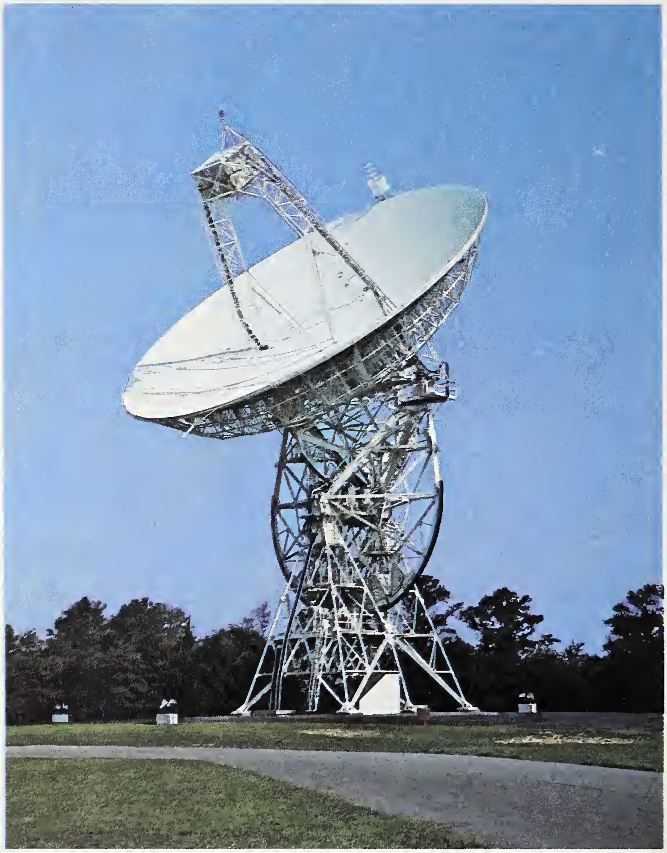
Around and around it goes. The next instrument you see shows how fast the wind is blowing. The picture on the right above shows this instrument. As the wind blows into the cups of the instrument, the cups spin around. The faster the wind blows, the faster the cups spin. Why might it be important to know how fast the wind is blowing? [1]

[1] **Sample answer:** Pilots and sailors need to know this to help them plot their course of travel. Meteorologists can tell about how fast the weather will change.

Suggested activity: After the pupils have read "Around and around it goes" and have looked at the picture of the anemometer, you might have the pupils make a wind sock, which is an instrument for measuring wind speed and direction. A wind sock is made out of material attached to a stick. As the wind blows, the stick turns to show direction, and the sock fills up to show the wind's speed.

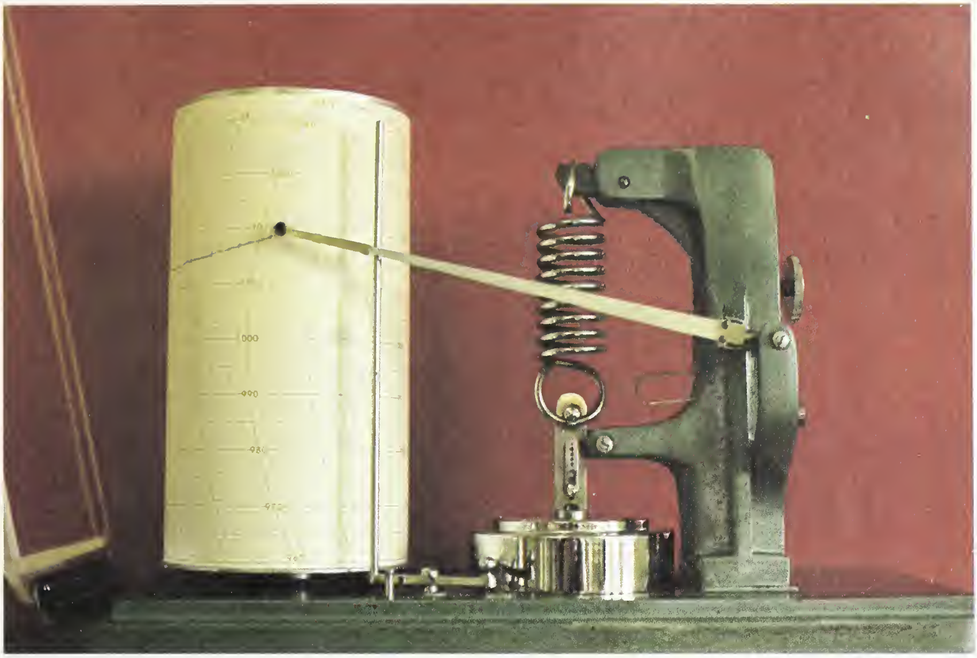
Tracking storms. Many weather stations also have a *radar antenna.* Radio waves are sent out in all directions. If a storm is in the area, some of the waves are bounced back like an echo. They show up on a screen. These waves show how far away the storm is. They also show how big it is. And they show how fast it's moving. How might this information be helpful to people?[1]

[1] **Sample answer:** It can alert them to prepare for the storm either by getting to a safe area or by protecting their belongings.



How do you think the shape of this radar antenna is helpful in sending and receiving radio waves?

Sample answer for the caption: The cone shape helps focus radio waves which are sent out from the antenna. The cone shape helps collect radio waves from the air and centres them to the receiving antenna.



This picture shows a kind of barometer used in a weather station. Where else have you seen a barometer?

High or low? You now go back inside the weather station. You and the meteorologist look at a *barometer* [buh-ROM-uht-ur]. It shows air pressure. When the air pressure is high, the marker on the barometer goes up. When it is low, the marker goes down.

Changes in the barometer reading can tell you what kind of weather might be coming your way. What kind of weather might you expect if the barometer is rising?[1] Falling?[2]

[1] **Sample answer:** Clear, cooler weather.

[2] **Sample answer:** Cloudy and warm weather.

Sample answer for the caption: In homes, at airports, at marinas.

Suggested research: After the pupils have studied the picture of the barometer on this page, you might have them find out what other barometers look like. Then you might have them draw and compare the barometers they have found.

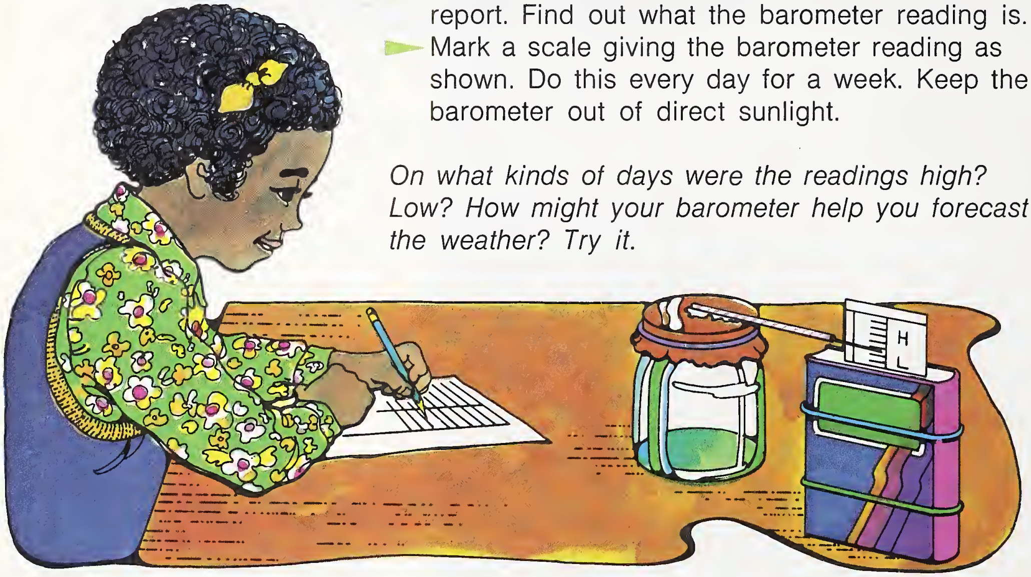
FINDING OUT

How can you "see" changes in air pressure?

You will need: balloon, quart bottle with wide mouth, book, straw, toothpick, piece of cardboard, glue, rubber bands

- Cut the balloon from one end to the other. Then pull it across the top of the bottle. Use a rubber band to keep it in place.
- Glue the toothpick to one end of the straw as shown.
- Glue the other end of the straw to the centre of the balloon as shown. You have made a barometer.
- Set up the card behind your barometer as shown.
- Check the newspaper or radio for the weather report. Find out what the barometer reading is.
- Mark a scale giving the barometer reading as shown. Do this every day for a week. Keep the barometer out of direct sunlight.

On what kinds of days were the readings high? Low? How might your barometer help you forecast the weather? Try it.



Teaching helps for "Finding Out":
Processes used: observing, measuring, comparing, collecting data.
Sample findings: On the days when the readings were high, the weather was most likely clear and cool. On the days when the readings were low, the weather was most likely warm and cloudy. The pupils might forecast the weather by watching for a change in the barometer reading. If the reading is high on one day and the needle begins to drop, rain might be forecast.

Fluffy forecasters

If you wanted to know the weather forecast, you could listen to the weather report on TV or radio. But you can sometimes learn about the weather in another way. Clouds are often used as signs of weather. That is, kinds of clouds often show what kind of weather may be coming.

There are clouds that look like white, soft pieces of cotton. They are called *cumulus* [KYOO-myuh-luhs] clouds. They often mean that the day will be fair and warm. And there will not be much humidity in the air. The word cumulus means pile. Do you think this is a good name for these clouds? Why?[1]

Sometimes you might see dark, gray clouds. They are called *nimbus* [NIHM-buhs] clouds. The word nimbus means rain. When have you seen this kind of cloud?[2]

Sometimes, you might see clouds that are spread out. They are called *stratus* [STRAT-uhs] clouds. These clouds are usually low and flat. If you see them, there is a lot of moisture in the air. Rain may come very soon.

Other times you might see curly-looking clouds. They are called *cirrus* [SIHR-uhs] clouds. These clouds are very high in the sky. When you see these clouds, rain or snow may be coming soon.

On some days, you may see many kinds of clouds at once. Then you know the weather will be changing soon.

Keep an eye out for different kinds of clouds the next few days. See if you can tell what kind of weather will be coming your way!

[1] **Sample answers:** Yes. Because they look like soft piles of cotton.

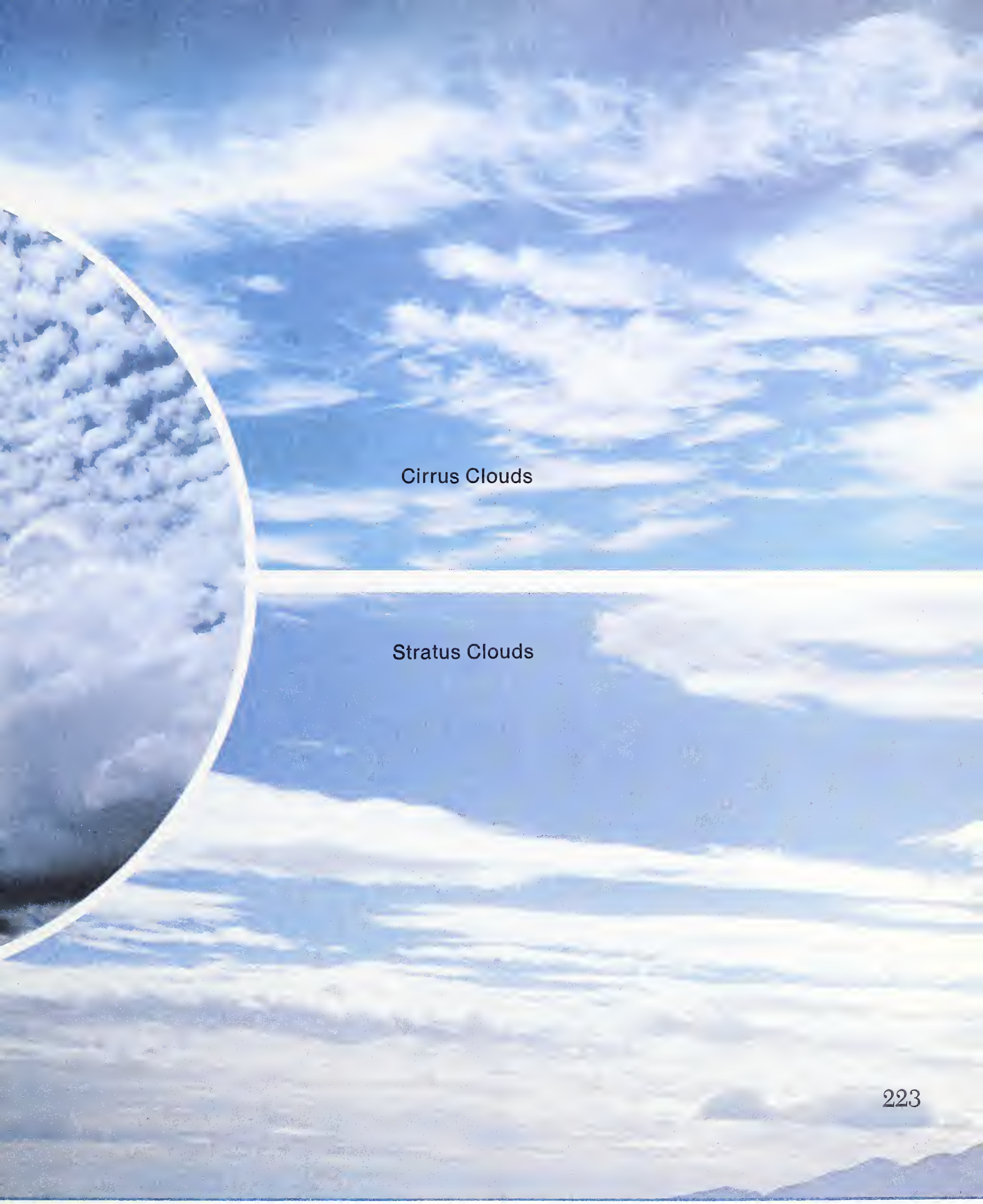
[2] **Sample answer:** Just before a rain.

For You to Think About

Cloudy nights are often warmer than clear nights. Why do you think this is so?

Sample answer for "For You to Think About": When the sun shines on the earth each day, the earth becomes very warm. Usually at night most of this heat escapes into the atmosphere. On cloudy nights, however, the heat is held to the earth by the cloud covering.

Cumulus Clouds
Nimbus Clouds



Suggested activity: When the pupils feel as though they can recognize the different clouds pictured above, you might have them do the following activity. Make a calendar for one month. Each day have them look at the clouds and report on their calendar which clouds they have seen. At the end of a month, you might have them report their findings, such as which clouds appeared most often and how accurately the clouds predicted certain weather.

Helping to change weather

There is an old saying, "People talk about the weather. But no one does anything about it." This was true until a few years ago. Now, some people have found ways to do something about weather.

As you may know, farmers need rain for their crops. A farmer's crops can be ruined without rain. One way to save crops is by "seeding" clouds.

Seeding clouds is a way of making rain. Airplanes spray *chemicals* [KEHM-ih-kuhlz] into the clouds. These chemicals may make water droplets form in the clouds. If it is cool enough, the water droplets will begin to fall. Rain is made!

Sometimes, however, crops get too much rain. This can also ruin crops. So, at times, farmers want to make clouds disappear. This might also be done by airplanes spraying chemicals into clouds.

Are there other times when it would be helpful to have clouds disappear from the sky? If so, when?[1]

[1] **Sample answers:** Yes. During flood seasons.

A Second Look

1. What do meteorologists do?
2. What are some of the instruments used by meteorologists? What is each used for?
3. What are some kinds of clouds, and what kind of weather might come with each?
4. What is meant by seeding clouds? How is it helpful to farmers?

Sample answers for "A Second Look": 1. Meteorologists study weather and try to forecast the weather. 2. Dry-bulb thermometers and wet-bulb thermometers measure the humidity in the air. A rain gauge measures how much rain has fallen. A weather vane tells the direction the wind is blowing from. An anemometer tells how fast the wind is blowing. A radar antenna tells how far away a storm is. A barometer measures air pressure. 3. Cumulus clouds often mean fair and warm weather. Nimbus clouds often bring rain. Stratus clouds often mean rain will come very soon. Cirrus clouds mean rain or snow may be coming soon. 4. Seeding clouds is a way of making rain by spraying chemicals in clouds. These chemicals help form water droplets. Farmers need rain to help their crops grow. During dry weather the seeding of clouds can bring the needed rain.

4 Stormy skies

What things do you picture in your mind when you think of a storm? Do you see leaves blowing in the wind? Dark clouds in the sky? People running to get inside buildings? Flashes of lightning? What other things might you think of?[1]

[1] **Sample answer:** Thunder, umbrellas, trees bent over in the wind, raincoats, wet feet, puddles, windshield wipers.

Main concepts of the chapter (pages 225–235):
There are many kinds of storms.
Some kinds of storms are windstorms, dust storms, rainstorms, tornados, and hurricanes.
Clouds can build up electric charges, which can cause lightning and thunder.
Storms can be helpful as well as harmful to people.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—name several kinds of storms;
—explain how some storms are caused;
—describe how thunder and lightning are made.

Important words: storm, windstorm, dust storm, rainstorm, tornado, hurricane, electric charges, thunder, rainbow.

Kinds of storms

There are many kinds of storms. Storms that are made up of wind alone are often called *windstorms.* And storms that are made up of dust and wind are called *duststorms.* Most storms have water in them. One such storm is a *rainstorm.* Rainstorms can be helpful to people. In what ways is this so?[1]

Another kind of storm is a *tornado* [tawr-NAYD-oh]. Tornadoes happen during summer or fall. They begin in a place where the land and the air are very hot. When cool air meets this hot air, the hot air begins to move. It moves up very fast in a whirl.

[1] **Sample answer:** Rainstorms help crops grow, supply water in streams for animals, supply water for people in cities, clear the air of smog.

FINDING OUT

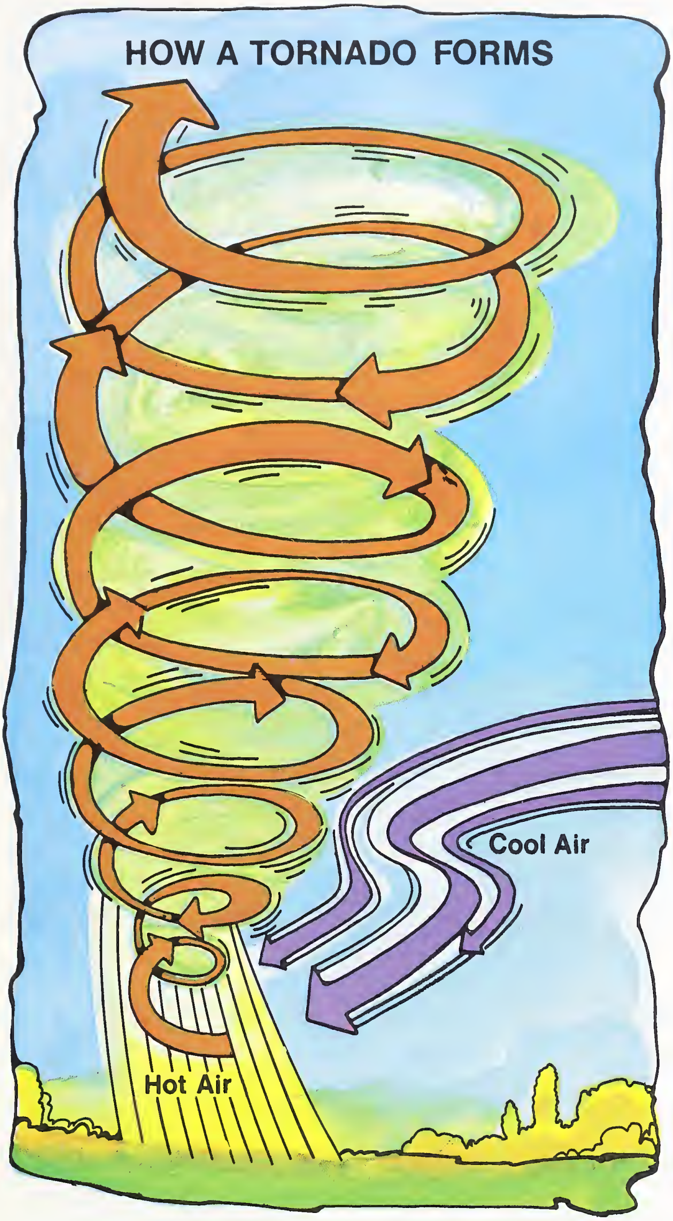
Does rain help clean the air?

You will need: flashlight, 2 chalkboard erasers, spray container of water

- ►Darken the room by turning off the lights or pulling down the shades.
- ►Clap the erasers together.
- ►Turn on the flashlight. Look for chalk dust in the air. Spray some water on the dust. (The water can be thought of as rain.)

What happens to the air when you spray the "rain"? Why?

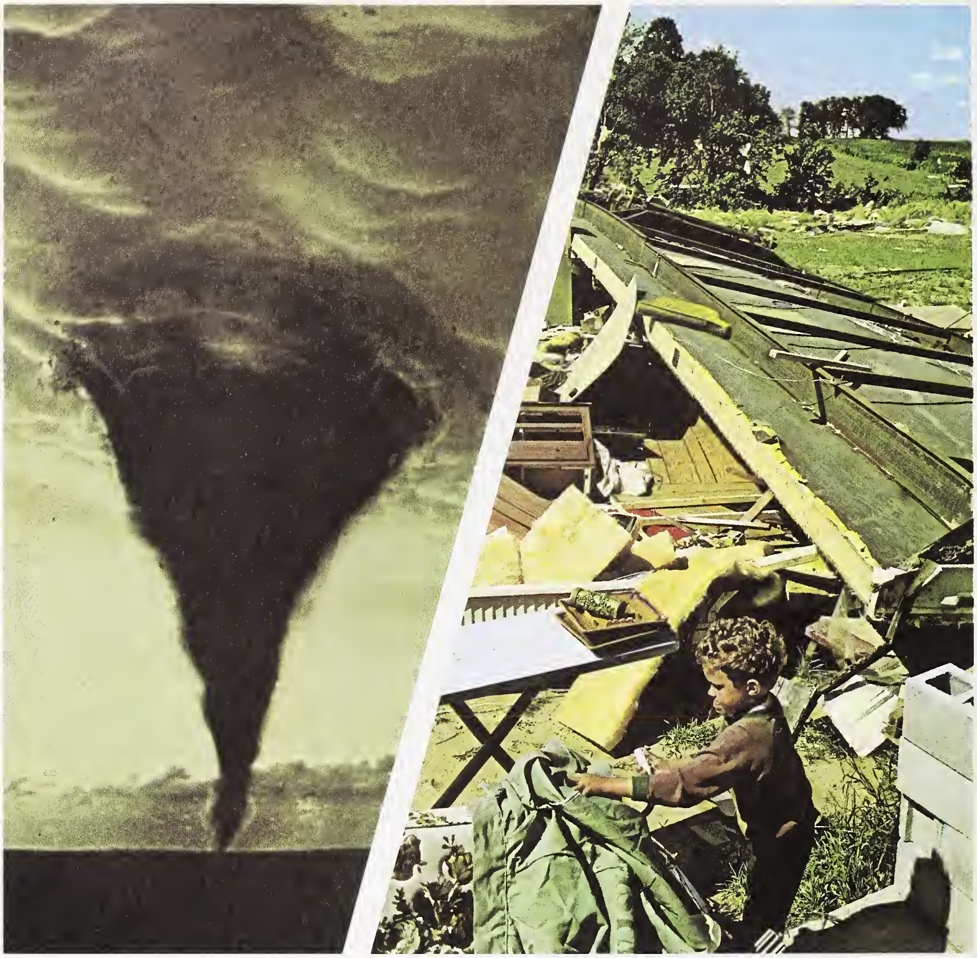
Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: When the water is sprayed in the air, the chalk-dust particles will stick to the water. This extra weight will cause the water mixed with chalk dust to fall to the floor, thus clearing the air of chalk dust.



For You to Think About

Sometimes on a day that isn't windy, you might see papers and dust swirling around and around over a hot pavement near a shady wall. Why do you think this happens?

Sample answer for "For You to Think About": The heat of the pavement and the coolness of the wall created a wind motion similar to a miniature tornado. It does not develop into a large tornado because the masses of cool and hot air are small.



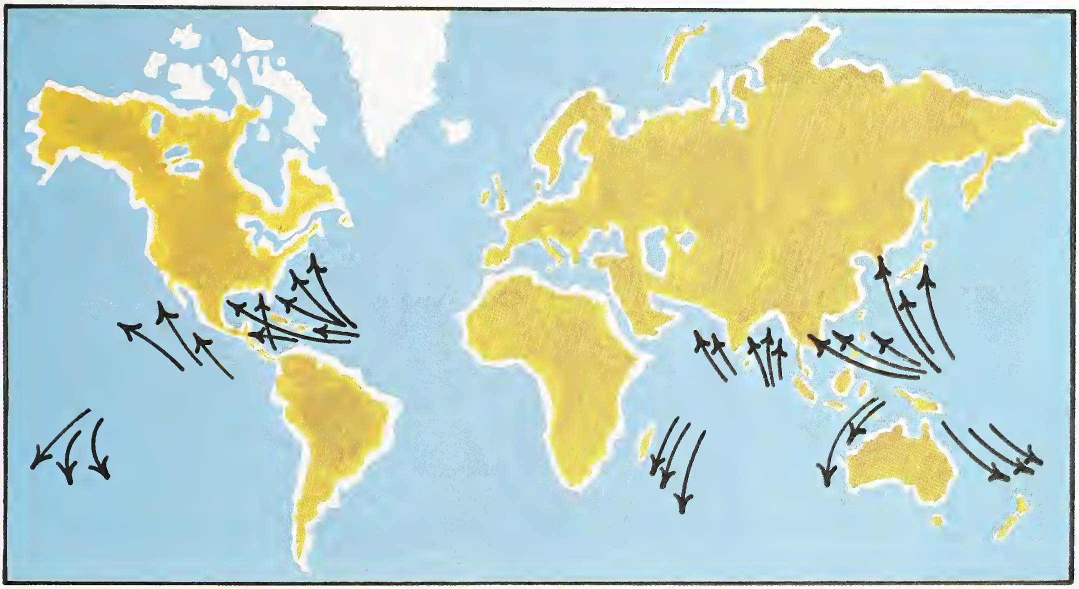
The picture on the left shows an approaching tornado. The picture on the right shows what happened to a place that was hit by a tornado. What things in the picture on the right show that a tornado's winds are very strong?[1]

[1] **Sample answer:** Buildings knocked down, trees and bushes uprooted.

There is another kind of storm with strong winds. It is called a *hurricane* [HUR-uh-KAYN]. Hurricanes form over the ocean. The map on this page shows those parts of the world where hurricanes occur.

Hurricanes happen during the summer or early fall. At these times of the year, the ocean and the air are warmer than at other times. The air above the ocean is also very moist. This warm, moist air rises very quickly. As it rises, it is cooled. This causes very strong winds. These winds move in a circle. As the hurricane nears land, the winds blow big waves of water onto beaches and cities. What do you think might happen to these beaches and cities?[1]

[1] **Sample answer:** Beaches might be worn away into the ocean from the force of the wind and water. Homes and other buildings may be torn down. Telephone and electrical poles may be blown over.



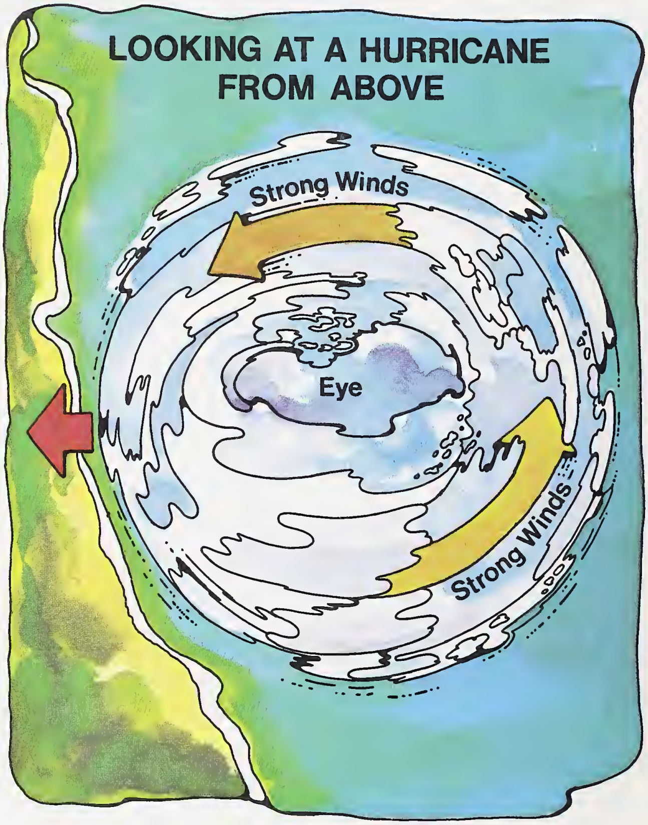
Suggested research: After the pupils have read and discussed the effects of tornados and hurricanes, you might have them find out the procedures for a town when tornado or hurricane seasons begin. Even if they do not live in tornado or hurricane "belts," they at some time may need to know what precautions should be taken.

Exploring on Your Own

Meteorologists can sometimes forecast when a hurricane will be coming. They can also forecast how strong the winds will be. Find out how they get this information. You might want to look in a reference book under the heading *hurricane.*

Hurricanes also bring a lot of rain. Heavy rains may bring floods. What kinds of damage do floods bring about?[1]

The winds of a hurricane are very strong. But the eye, or center, is very quiet and still. When the eye moves over a town or city, many people think the hurricane has gone past. Some of them might go outdoors. Why might this be dangerous?[2]



[1] **Sample answer:** Flooding in homes can ruin furniture and other belongings. Land erosion can keep plants and crops from growing. Wild animals are moved from their home.

[2] **Sample answer:** They would not be prepared when the strong winds and rain came again.

Sample findings for "Exploring on Your Own": Pilots can fly over hurricanes to take pictures of their size and movement. These pictures combined with the meteorologist's information about wind speed and high- and low-pressure zones can help a meteorologist determine how fast a hurricane is moving and how hard its winds are blowing.

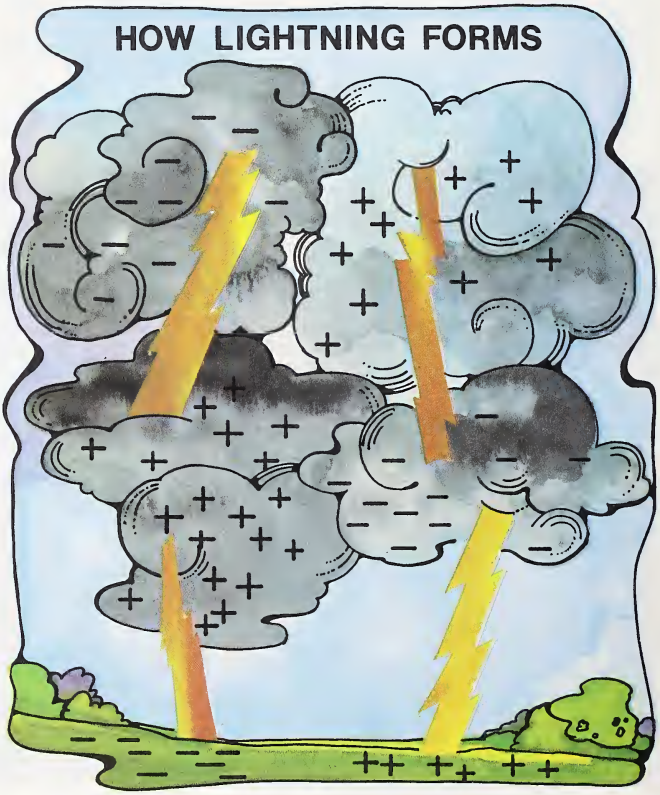
Flashes of lightning

There may have been times when you have seen flashes of lightning during a storm. If so, you may have wondered what happened to make the bright flashes you see.

Have you ever walked on a rug, touched a doorknob, and felt a shock? If so, the shock happened because of *electric charges*. You cannot see these charges. But as you walked on the rug, these charges were rubbed off the rug. They went onto your shoes. Then they went onto your clothes and your hand. When you touched the doorknob, the charges "jumped" from your hand to the doorknob.

Clouds can also build up electric charges. This happens during a storm when the clouds are moving fast. The clouds "rub" together. This causes them to build up electric charges. When you see lightning, you see these charges jump from one cloud to another. Or, lightning may jump from a cloud to the ground.

Lightning between clouds does not harm anything on the earth. But when there is lightning



Clouds build up two kinds of charges—positive (+) and negative (—). Lightning occurs between areas of positive and negative charges because these charges of energy are attracted to each other.

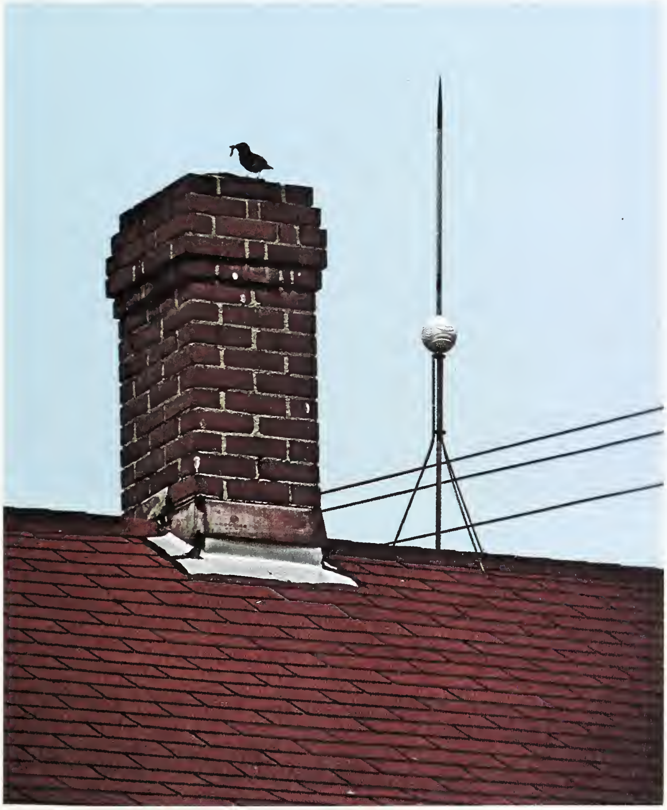
between clouds and the earth, a lot of harm can be done. People and animals have been killed by lightning. Lightning is harmful in other ways, too. How?[1]

Even though lightning can be harmful at times, it can also be helpful. It helps plants get the nitrogen that they need. As you may remember, there is nitrogen in the air. Lightning changes nitrogen into a form that plants can use. Rain-

Exploring on Your Own

There are some places that are safer than other places when there is lightning. Find out where you should go when you are outside and you see lightning.

[1] **Sample answer:** The extreme heat may cause forest fires. If lightning hits electrical or telephone wires, people have no electricity or telephone communication.



Many buildings are protected from lightning by metal rods. Lightning which strikes these rods is carried harmlessly along wires to the ground. On which buildings have you seen lightning rods?

Sample findings for "Exploring on Your Own": Safe places are in cars, houses, and buildings. If out in an open field a person should lie flat or find a ditch. A dangerous place would be under a tree. **Sample answer for the caption:** Homes, schools, office buildings, apartments.

drops carry this nitrogen down to the ground. Then the roots of the plants take up some of the nitrogen from the soil.

Noisy clouds

Thunder is the sound you hear after you have seen lightning. As lightning travels, it heats the air around it. The sudden heating of the air makes the air take up more space. This air then pushes against cooler air. This all happens so quickly that a sound is made. This is the sound of thunder that you hear.

Lightning and thunder happen at the same time. But you often see lightning before you hear thunder. Why do you think this is so?[1]

Colours in the sky

Have you ever been outside on a sunny day when rain was falling? If you were standing with your back to the sun, you might have seen a rainbow. The colours of the rainbow are made by the sun's light.

When you see sunlight, it may not seem to have colour. But sunlight is made up of many colours. Sunlight must be "broken up" before you can see these colours. When sunlight passes through raindrops, it is sometimes broken up. It is broken up into the colours of the rainbow that you see. What colours do you see in the rainbow shown on the next page?[2]

[1] **Sample answer:** Light travels faster than sound.

[2] **Sample answer:** Yellow, green, blue, purple, red, orange.

A Second Look

1. What are some kinds of storms?
2. What causes lightning? Thunder?
3. How is a rainbow made?

Sample answers for "A Second Look": 1. Windstorms, dust storms, rainstorms, tornadoes, hurricanes, and storms with thunder and lightning are some kinds of storms. 2. Lightning is caused when clouds rub and build up electric charges. Lightning can be seen when these charges jump from one cloud to another. When lightning travels, the air around the lightning is heated. The heated air pushes against the cooler air. This happens so quickly that the sound of thunder is made. 3. When sunlight passes through raindrops, it may be broken up into its many colours.

Workers Who Use Science

Besides meteorologists, there are other people who study weather. Some of these people are called *weather observers* [uhb-ZUR-vurz].

Weather observers often work in small towns or small cities. They find out about the weather in these places. They do this by using weather instruments. They also check the clouds to find out about the weather. What things do you think they might find out about the weather by checking the clouds?

After weather observers find out about the weather near them, they send this information to meteorologists in larger cities. They send this information about every six hours. The meteorologists use this information in putting together their weather forecasts.

To find out more about weather observers, try to find answers to these questions and others you may have about weather observers:

What are some of the instruments weather observers use?[1]

Can weather observers find out how much pollution is in the air? If so, how?[2]

Why is it important for weather observers to know about weather maps?[3]

Along with sources of your own, writing to the following place may help you: Department of the Environment, Atmospheric Environment Service, Ottawa, Ontario K1A 0H3.

Sample answers for "Workers Who Use Science":

[1] Weather vanes, barometers, wind socks, thermometers.

[2] Yes. Weather observers measure the pollutants in a small area and judge the average for a large area.

[3] So they can know about the weather near them and predict tomorrow's weather.

Reviewing the Main Ideas

The air around you is made up of many things.
Gases, smoke, and dust are some of these things.
Moist air weighs less than dry air.
Air pressure is caused by the weight of the air pressing down on things.
When air is warmed, it takes up more space than when it is cooled.
The movement of warm air and cold air is what makes wind.
When water evaporates, it changes into water vapour.
Clouds are made when dust and water vapour are mixed and cooled.
Meteorologists are people who study weather and make weather forecasts.
Certain kinds of clouds can show what kind of weather might be coming.
Seeding clouds is a way of making rain.
There are many kinds of storms.
Storms can be helpful as well as harmful to people.

Reading About Science

Aikman, J.A. *Watching the Weather Change.* Toronto, Ontario: Macmillan Company of Canada Ltd., 1975.
Kalina, Sigmund. *Air, the Invisible Ocean.* Agincourt, Ontario: Gage Publishing Limited, 1973.
McInnes, John and Murray, William. *The Weather.* Don Mills, Ontario: Thomas Nelson & Sons (Canada) Ltd., 1975.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 238.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to the topic of weather. Such articles might be found in reference books under the headings *hurricane, meteorology,* and *clouds.*

Testing for Understanding

Ideas to Check

On your paper write *T* for each sentence below that is true. Write *F* for each one that is false.

F 1. Though air is important to you, it has nothing to do with weather.
T 2. There are times when you can feel water vapour.
T 3. Clouds are mostly made up of dust and water vapour.
T 4. There are times when you might feel air pressure.
F 5. Air has no weight.
T 6. When low-pressure air comes your way, it often brings warm, cloudy weather.

Words to Use

Write on your paper the word that best fits in each blank below. Choose from these words: *chemicals, tornado, thunder, oxygen, humidity, weather, windchill.*

1. A ____ can make you feel colder than you expect from what the thermometer shows. windchill
2. One of the most important gases which make up air is ____. oxygen
3. Sometimes ____ are sprayed into clouds to make rain. chemicals
4. The sound you hear after you see lightning is ____. thunder
5. The amount of water vapour in the air is called ____. humidity

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Air and Weather" are provided for you on page T20 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22 of the Teacher's Manual.

Having Fun with Science

Is It True?

Listed below are a few sayings about weather. See if you can figure out what they mean. Also see if you can find out if they are true.

Dark clouds in the west—
stay indoors and rest.[1]

When the sunset is clear,
a cool night draws near.[2]

A ring around the sun or moon
brings rain or snow upon you soon.[3]

Smoke drifting lazily
close to the ground
Tells us that rain
may be coming 'round.[4]

Fun with Words

How many little words can you find in each of these words? Each letter of a word can be used more than once.

temperature
moisture
hurricane
weather
thermometer
forecast
meteorologist
rainbow
tornado

Something to Do

Many clouds have shapes that sometimes look like people, animals, or things. On a cloudy day, make a list of what you can "see" in the clouds.

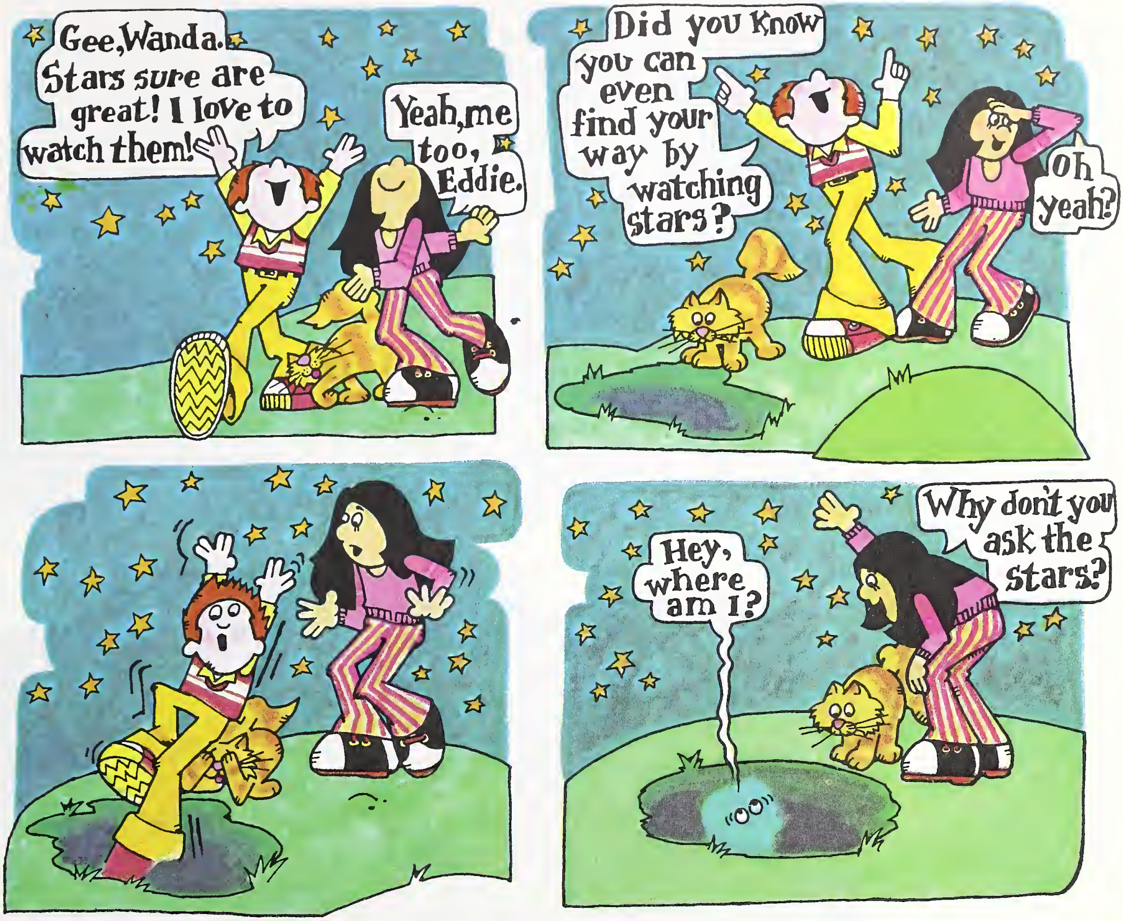
For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of the unit "Air and Weather." You may also wish to encourage the pupils to make up additional activities related to the topics of air, weather, and temperature.

Sample answers for "Is It True?": [1] True. Most weather patterns move from west to east. [2] True. When there are no clouds, heat in the air escapes above the earth. [3] True. Moisture in the air reflects the moonlight to make a bright ring. [4] True. Large amounts of humidity in the air keep smoke from rising.

6 Watching the Sky

1 A sky full of stars
2 A special star
3 The planets
4 The moon

Preparing for the unit: For a list of instructional materials helpful in teaching this unit, see pages T14–T15 of the Teacher's Manual. You may also wish to check the list of materials needed for each "Finding Out" activity in this unit and have the pupils begin collecting these materials. These activities are found on pages 244, 245, 250, 252, 256, 260, 263, 265, 276, and 277.


Gee, Wanda. Stars sure are great! I love to watch them!
Yeah, me too, Eddie.
Did you know you can even find your way by watching stars?
Oh yeah?
Hey, where am I?
Why don't you ask the stars?

Do you think the stars can be used to help find your way? If so, how?[1]

Why else might people watch stars?[2]

What other things might people watch in the sky?[3]

Introducing the unit: You may wish to have the pupils read the cartoon above. Then have the pupils read the questions below the cartoon and discuss their answers to the questions.

Sample answers for questions below the cartoon:

[1] Yes. By learning where certain stars are usually found in the sky and by following them.

[2] Because they think stars are pretty.

[3] The sun, the moon.

1 A sky full of stars

Stop for a minute and think about the last time you looked at the sky on a clear night. You probably saw many stars. From earliest times, people have watched the stars in the sky. Long ago, farmers watched some stars to know when to plant their crops. Other people watched some stars to find their way when traveling.

Stars are still important to many people today. Sailors and other people watch stars to find their way. Some people watch stars because they think stars are beautiful. What do you think about when you watch stars?[1]

[1] **Sample answer:** How far away they are, what makes them twinkle, why some are brighter than others, why I can't see them every night.

Main concepts of the chapter (pages 242–250):

A star is made up of hot gases which give off light.

Stars twinkle because moving air causes light from the stars to move back and forth a bit.

The colour of a star depends on how hot it is.

Stars seem to move because the earth is moving.

To many people, some groups of stars seem to make up pictures.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—describe what a star is;
—demonstrate why stars twinkle;
—explain why stars are different colours;
—explain why stars seem to move;
—list some star groups which form pictures.

Important words: stars, constellations.

What are stars?

For many years, little was known about stars. Most people thought that stars were little lights in the sky. But today, it is known that most stars are many times bigger than the earth. Stars only seem small because they are very far away. In fact, some stars are so far away that it would take millions of years to get to them by spaceship!

Another thing known today about stars is that they are made up of hot gases. A gas is something that has no shape of its own. Air is made up of many kinds of gases.

The gases that make up a star are so hot that they give off light. Though this light shines all the time, you may not always be able to see it. Why do you think this is so?[1]

[1] **Sample answer:** Because clouds may block the light from a star on some nights.

For You to Think About

Some stars are brighter than others. Why do you think this is so?

Sample answer for "For You to Think About": Because they are made up of hotter gases than others, and because they are closer than others. **Suggested research:** After discussing the material on this page, you may wish to point out to the pupils that people sometimes need to estimate how far away stars are. When people do this, they use units called light-years. You may then want to have the pupils find out about light-years and how people estimate the distance to a star. Have the pupils look in reference books under the headings *astronomy*, *parallax*, and *light-year*.

FINDING OUT

Why are most stars seen only at night?

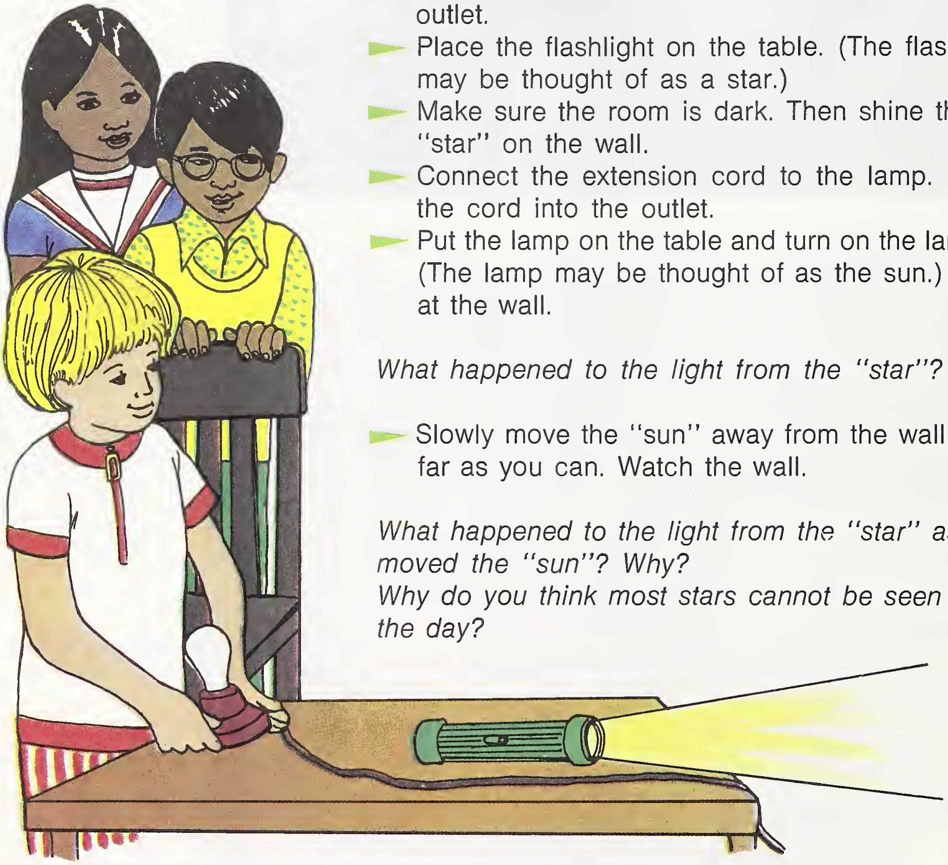
You will need: table, flashlight, bright lamp, extension cord, dark room

- Put the table near a wall which has an electric outlet.
- Place the flashlight on the table. (The flashlight may be thought of as a star.)
- Make sure the room is dark. Then shine the "star" on the wall.
- Connect the extension cord to the lamp. Plug the cord into the outlet.
- Put the lamp on the table and turn on the lamp. (The lamp may be thought of as the sun.) Look at the wall.

What happened to the light from the "star"?

- Slowly move the "sun" away from the wall as far as you can. Watch the wall.

What happened to the light from the "star" as you moved the "sun"? Why?
Why do you think most stars cannot be seen during the day?



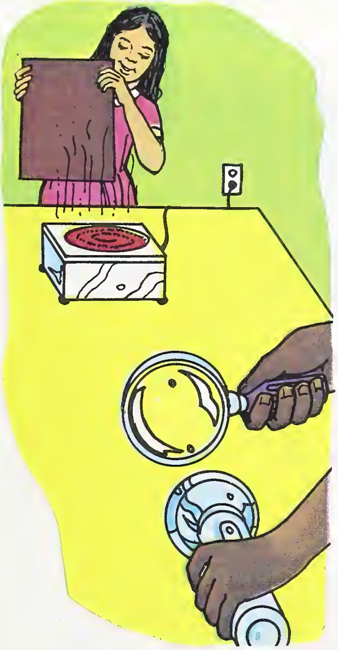
Teaching helps for "Finding Out":
Processes used: observing, communicating, inferring, hypothesizing.
Sample findings: After the pupils turn on the lamp, or the "sun," they will most likely observe that the light from the "star" cannot be seen. As the pupils move the "sun" away from the wall, they will probably observe that the light from the "star" becomes more visible. The pupils may state that the light from the "star" is more visible when the "sun" is farther away because the light from the "sun" is less bright. From this activity, the pupils will probably infer that most stars cannot be seen during the day because the sun is too bright.

Why do stars twinkle?

As you may know, light from a star must shine through the air before you can see the star. Air is always moving. When it moves, it causes light from the star to move back and forth a bit. When the light moves, it makes the star twinkle.

Suppose you were to watch a star every night for a week. Do you think it would twinkle in the same way every night? Why or why not? 1

[1] **Sample answers:** No. Because the air moves differently on different nights.



FINDING OUT

How can you make light twinkle?

You will need: flashlight, dark paper, magnifying glass, source of heat such as a hot plate or a radiator

- Have someone hold the paper about 1 metre (3 feet) away from you.
- Shine the flashlight through the magnifying glass onto the paper.

What do you see on the paper?

- Have someone hold the paper behind and above the source of heat.
- Shine the flashlight through the magnifying glass onto the paper as shown.

What happened to the light on the paper? Why?

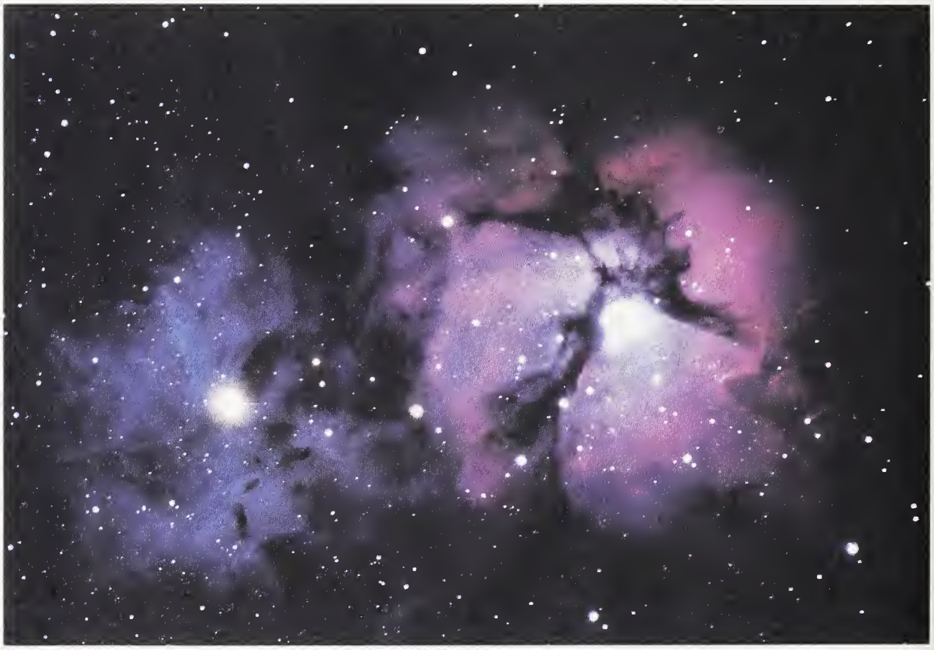
Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: When the pupils first shine the flashlight on the paper, they will most likely observe a small circle of light focused on the paper. When they shine the flashlight over the source of heat, they will probably see that the circle of light moves back and forth. The pupils may then infer that the warm air moving from the heat source causes the light to move.

Why are stars different colours?

You may have seen that stars twinkle. But have you seen that they are different colours? If you look carefully at a star, you may see that it is either red, orange, yellow, white, or blue-white. The colour of a star depends on how hot the star is. The coolest stars are red. The hottest stars are blue-white. Why do you think some stars are hotter than others?[1]

[1] **Sample answer:** Because their gases are hotter than others.

This picture of stars was taken through a telescope. The picture also shows a large body of gases and dust called a nebula. What colours do you see in the stars in this picture?



Sample answer for the caption: White, blue-white, yellow, orange.

Suggested activity: After discussing "Why are stars different colours?" you may wish to involve the pupils in an activity which would help them see why stars differ in colour because of their heat. Have the pupils hold a wire with pliers over a flame. As the wire becomes hot, the pupils will see it glow red, then orange, then yellow.

Why do stars seem to move?

Did you ever look at a star early in the evening and then try to find it later that night? If so, you know that a star is not always found in the same part of the sky. Why do you think this is so? 1

At some time, you may have turned in circles like a spinning toy top. If you did, you may have seen that the things around you seemed to move as you turned. In the same way you turned, the earth turns. As the earth turns, the stars around it seem to move. Why do you think stars seem to move slowly? 2

Exploring on Your Own

As you may know, most stars are found in different parts of the sky at different times of night. However, one star is found in much the same place all the time. This star is called the *North Star*. See if you can find out why the North Star does not seem to move. Look in reference books to help you.

[1] **Sample answer:** Because the earth moves, which makes the stars look like they move across the sky.

[2] **Sample answer:** Because they are very far away.

What are constellations?

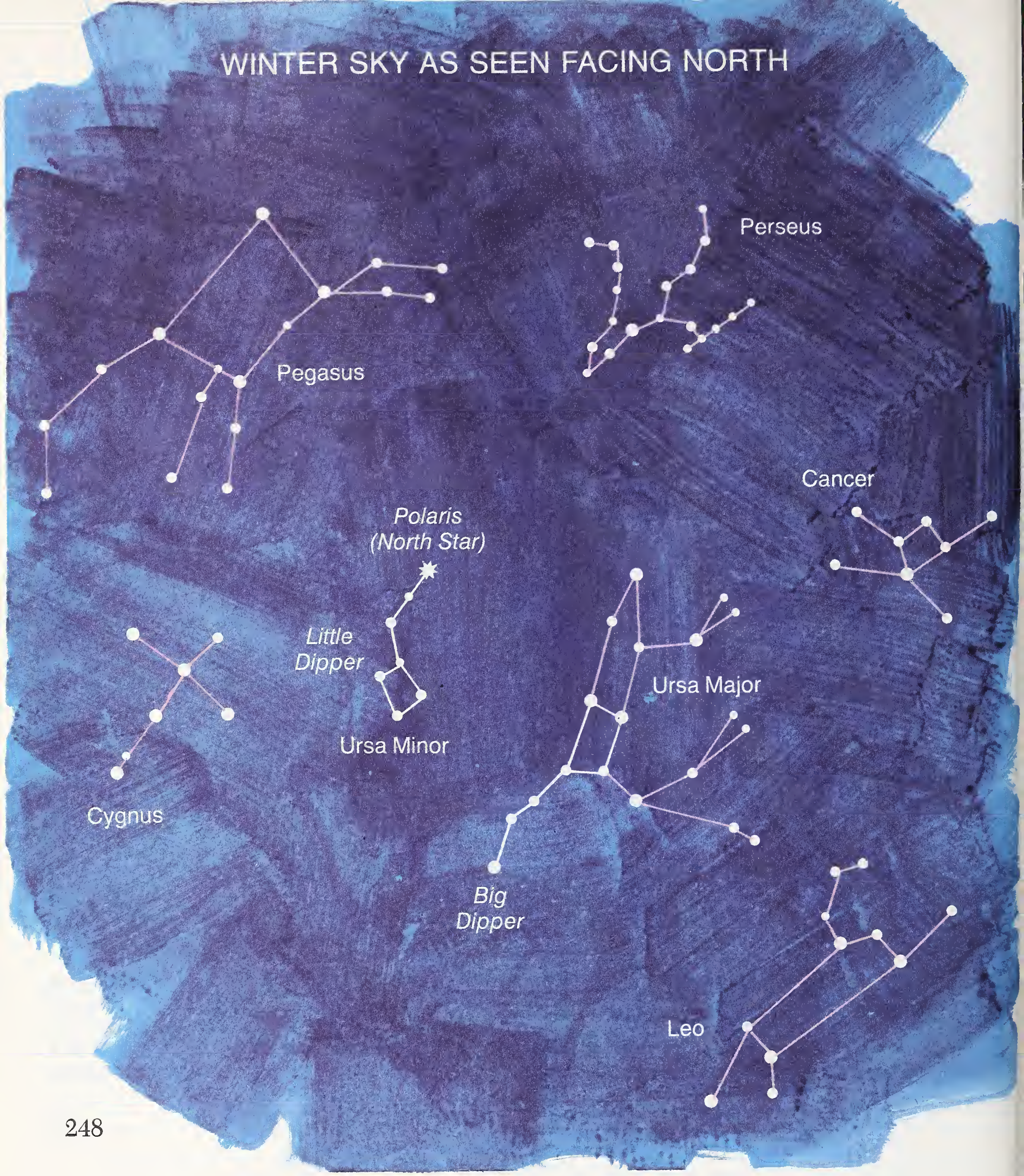
Another thing you may have seen about stars is that they are always found next to the same stars. Long ago, people saw that many stars were in groups. These groups seemed to make up pictures of things people knew. So, people named the groups for these things. One group of stars looked like a lion to many people. This group is called Leo. Leo was a lion in an old story. Two other groups looked like dippers. These groups are called the Big Dipper and the Little Dipper.

Today, groups of stars which make up pictures are known as *constellations* [KON(T)-stuh-LAY-shuhnz]. If you look on pages 248 and 249, you will see some constellations. If you had seen these constellations first, what would you have named them? 3

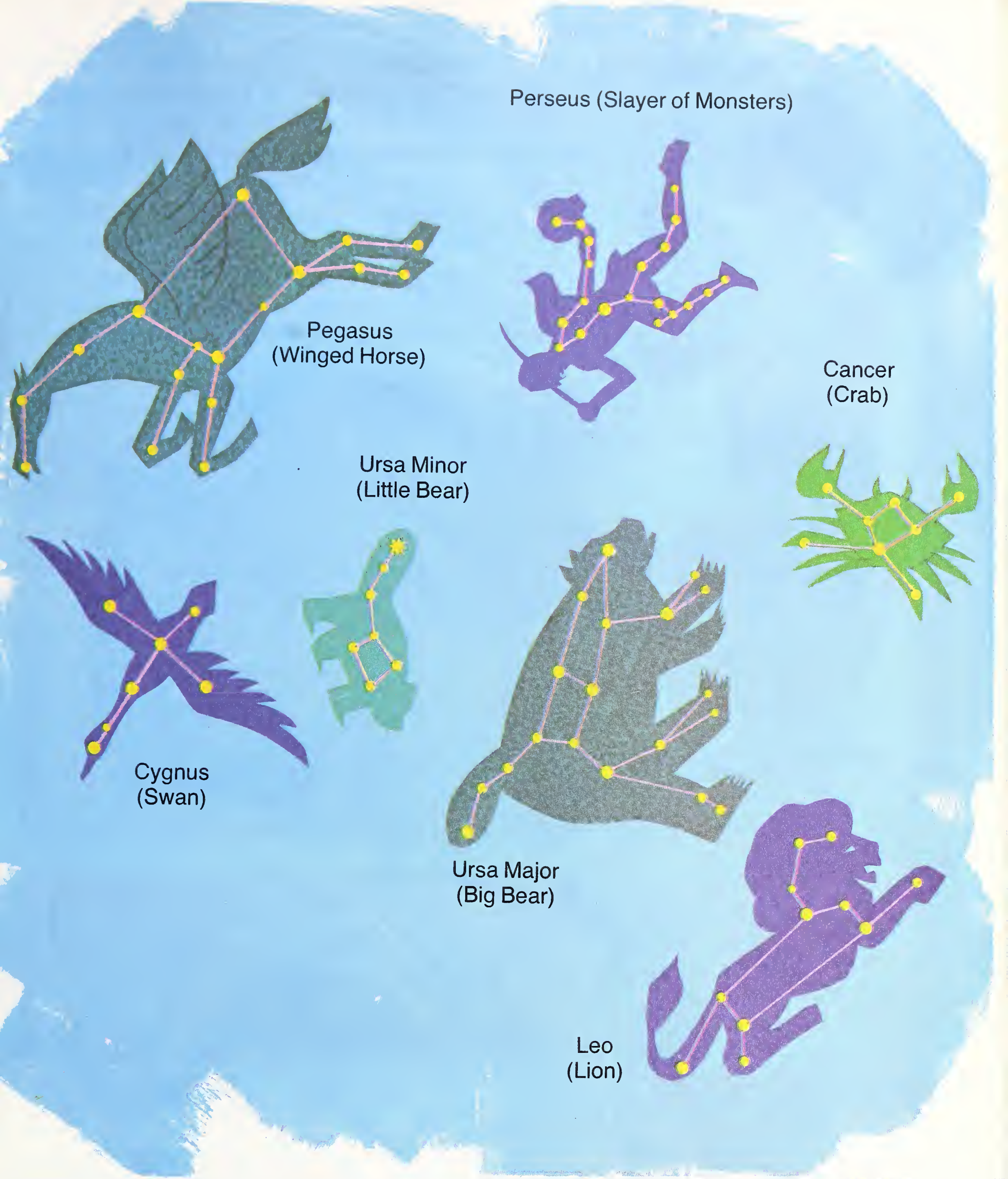
[3] **Sample answer:** I would have named Cancer for a spider, Leo for a horse, Ursa Major for a mouse, Cygnus for a cross, Ursa Minor for a cup and a straw, Perseus for a bird, and Pegasus for a giraffe.

Sample findings for "Exploring on Your Own": The North Star is found above the earth's axis. As the earth turns around its axis, this star does not seem to move.

Suggested research and activity: At this point, you may wish to have each pupil look in reference books under the heading *constellation* to find a constellation. Then have the pupils line a shoe box with aluminum foil and cut a hole in one end of the box for the bulb end of a flashlight. Next have the pupils cut off the other end of the box, tape the lid to the top, and cut a piece of black paper to the size of the end of the box. In the paper, have the pupils poke small holes forming the pattern of their constellation. Have them tape the paper to the open end of the box and put their flashlight in the other end. In a dark room, the pupils may shine the flashlight on the ceiling so that the other pupils might guess the name of their constellation.



Suggested activity and discussion: After discussing the picture on this page, you may wish to have the pupils try to find some familiar constellations in the sky early one night. Have the pupils draw a picture of the constellations to show their position in the sky. Then have the pupils draw similar pictures one hour and two hours later and compare their pictures. You may then wish to ask these questions: What did you find when you compared your pictures? Why? (Sample answers: The constellations were in different parts of the sky at different times. Because the earth is turning around its axis, which makes the stars seem to move across the sky.) Then you might have the pupils draw a picture of these constellations at a certain time one night a week for four weeks. Next have the pupils compare these pictures to see that stars also change position in the sky because the earth is traveling around the sun.



Suggested research: After discussing the pictures on pages 248 and 249, you may wish to have the pupils find the stories from which many of the constellations in the pictures received their name. The pupils may find these stories by looking in reference books under the headings of individual constellations such as *Big Dipper* or *Little Dipper*, or under the heading *mythology.*

FINDING OUT

How can you make a telescope?

You will need: 2 magnifying glasses, thin cardboard, scissors, tape

- Make a tube out of cardboard and tape. The tube should be about 25 cm long. It should be wide enough for one of the magnifying glasses to fit tightly inside.
- Make another tube about 25 cm long. This tube should fit tightly inside the first tube but should be wide enough for the other magnifying glass to fit inside.
- Tape a magnifying glass to one end of each tube.
- Put the tubes together as pictured. Now you have made what is called a *telescope*.
- Look at some stars through your telescope.
- Move the inside tube in and out until you can see the stars clearly.

How is looking at stars with the telescope better than looking at stars without the telescope?

A Second Look

1. What are stars and why are they important?
2. Why do stars twinkle?
   Why are stars different colours?
4. Why do stars seem to move?

Teaching helps for "Finding Out":
Processes used: observing, comparing.
Sample findings: After the pupils look at some stars through their telescope, they will most likely state that the telescope makes the stars look clearer than they look without the telescope.
Additional information: The combination of a thick, convex lens and a thin, convex lens will produce the best results for this activity.

Sample answers for "A Second Look": 1. Stars are bodies in the sky which are made up of hot gases. Stars help many people find their way. 2. Stars twinkle because their light moves back and forth a bit as it passes through moving air. 3. Stars are different colours because of how hot they are. 4. Stars seem to move because the earth is turning around its axis.

2 A special star

If someone asked you what you knew about the sun, what would you say? Would you say that it is a large, bright light in the sky? Would you say that the sun is so bright that it can hurt your eyes if you look at it? Would you say that the sun can keep you warm? These are just a few of the things many people would say. What else would you say about the sun?[1]

[1] **Sample answer:** It is many miles away. It is too hot for a spaceship to land on. It is needed by plants.

What is the sun?

Most people have seen the sun hundreds of times. But there is something about the sun that some people may not realize. That is, the sun

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Main concepts of the chapter (pages 251–256):
The sun is a medium-sized star.
The sun is the closest star to the earth.
The sun is important to the earth because the sun gives off heat and light.
The sun is important because it may help people find directions and tell time.

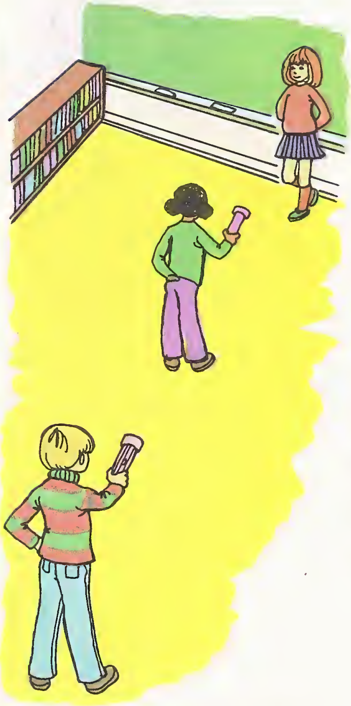
Performance objectives: After studying the information provided in this chapter, the pupils should be able to
—explain what the sun is;
—state four ways the sun is important.
Important words: sun, electricity, oxygen, east, west, north, south, sundial.

is a star. If this is so, why does the sun look bigger than other stars? [1]

Though the sun looks bigger than other stars, it is a medium-sized star. Many stars are bigger than the sun. Many other stars are smaller than the sun. The sun looks so big because it is the closest star to the earth. In what other ways is the sun different from other stars?[2]

[1] **Sample answer:** Because it is closer to the earth than other stars are.

[2] **Sample answer:** It is brighter, closer to the earth, and warms the earth.



FINDING OUT

Why does the sun seem brighter than the other stars?

You will need: 2 flashlights of the same brightness, dark room

- Give a flashlight to 2 other people.
- Stand by a wall.
- Have one person stand near you. (The light this person is holding may be thought of as the sun.)
- Have the other person stand across the room from you. (The light this person is holding may be thought of as another star.)
- Have the people shine their "stars" toward you.

Which "star" seems brighter? Why? Why does the sun seem brighter than the other stars?

Teaching helps for "Finding Out":
Processes used: observing, comparing, inferring, using spatial relationships.
Sample findings: After shining the "stars," the pupils will most likely observe that the "star" closer to the wall seems brighter than the other "star." The pupils may infer that this "star" seems brighter because it is closer to them. They might also infer that the sun is brighter than the other stars because it is closer to the earth than the other stars.

Why is the sun important?

Along with being the closest star to the earth, the sun is the most important star to the earth. In what ways do you think the sun is important? [1]

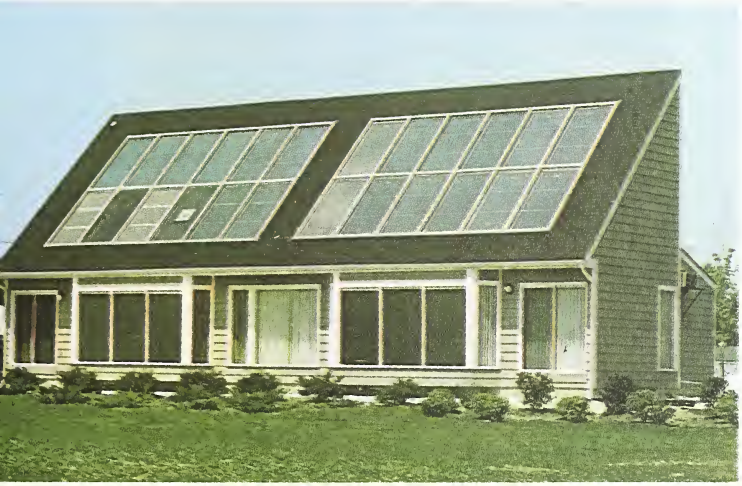
Heat. Have you ever put your hand by a window where sunlight was shining in? If you have, you may know that the sun gives off heat. This heat warms the air and ground. Why do you think it is important that the air and ground are warmed? [2]

People are trying to find new ways to use the heat that comes from the sun. One way people would like to use this heat is to warm homes. Another way people would like to use it is to make *electricity* [ih-LEHK-TRIHS-uht-ee]. Why might finding new ways to use heat from the sun be important? [3]

[1] **Sample answer:** It gives the earth warmth and light.

[2] **Sample answer:** Because living things would die if the earth were too cold.

[3] **Sample answer:** Because some of the things we use now to make heat, such as gas and oil, are limited and may someday be used up.



The roof of this house has special parts that collect sunlight. The sunlight is then changed into heat and electricity for the house. What problems might have to be worked out in such a house?

Sample answer for the caption: How to store heat and electricity from sunlight to be used when the sun does not shine, and how to make such a house less expensively.

Suggested discussion: After discussing "Heat," you may wish to help the pupils understand the importance of electricity. You might do this by asking the pupils this question: What are some things you know of that need electricity in order for them to work? (Sample answer: Lamps, streetlights, ovens, irons.)

Light. Besides giving off heat, the sun is important in another way. Light from the sun helps green plants make their food. When the plants make this food, they give off *oxygen* [OK-sih-juhn] into the air. Oxygen is a gas. Animals and people breathe oxygen to live. They also eat green plants to live.

What do you think would happen if green plants did not get enough light from the sun? [1] How else is light from the sun important? [2]

Finding directions. Like other stars, the sun is important because people can use it to help find their way when traveling. How do you think people use the sun in this way? [3]

Suppose you looked toward the sun in the morning and then in the afternoon. When you looked toward the sun in the morning, you faced

[1] **Sample answer:** They could not make their own food and would die. If they died, all other life would die on the earth because green plants are food for many animals and people, and animals that eat green plants are food for people and other animals.

[2] **Sample answer:** It helps some living things see; it may help people tell time.

[3] **Sample answer:** They know what part of the sky the sun should be in at certain times during the day. This helps them know which direction they face.

Suggested discussion: After discussing "Finding directions" on pages 254 and 255, you may wish to ask the pupils these questions: Do you think using the sun to find directions is possible in all kinds of travel? Why or why not? (Sample answers: No. Because the sun is not always visible, such as at night, on cloudy days, and in deep water.)

one direction. That direction is *east*. When you looked toward the sun in the afternoon, you faced another direction. That direction is *west*. How might knowing these directions be helpful to you when traveling?[1]

How might you use the sun to find the directions *north* and *south*?[2]

Telling time. The sun is important in still another way. It may be used to tell time. How might you use the sun to tell time?[3]

Long ago, people could tell time only by using the sun. The first clocks worked only when the sun shone. One of these clocks is called a *sundial*. The picture below shows one kind of sundial. How might this clock be used to tell time?[4]

For You to Think About

At some time you have probably heard someone say that the sun rises in the morning and sets in the evening. Do you think the sun really rises and sets? Why or why not?

[1] **Sample answer:** If I know that the place I am trying to find is in a certain direction such as west, then knowing which way west is will help me get there.

[2] **Sample answer:** If I know that the sun is in the west in the afternoon, then I know that north is to the right of the sun and south is to the left. If I know the sun is in the east in the morning, I know that north is to the left of the sun and south is to the right.

[3] **Sample answer:** By looking at its position in the sky. If the sun is above me, I know that it is about noon.

[4] **Sample answer:** By looking at the shadow made by the part that sticks up. The clock should be placed so that 12 o'clock faces north. In the morning the shadow will be on the higher numbers. In the afternoon the shadow will fall on the lower numbers.

Sample answers for "For You to Think About": No. It just seems as if the sun is moving because the earth is moving.

Suggested activity: After discussing "Telling time," you may wish to involve the pupils in an activity which would help them discover how the sun may be used to tell time. First, have the pupils find a tree or a flagpole which is away from other things. On a sunny day, have the pupils find the direction north. Once the pupils have found north, have them face that direction and the tree or flagpole. You might then ask the pupils to tell what time it is. They may do this by finding the shadow of the tree or pole and estimating where on a clock this shadow might be pointing.

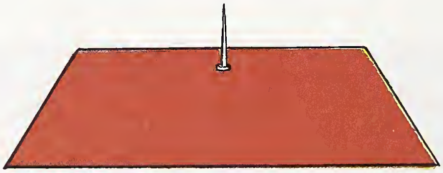
FINDING OUT

How can you make a sundial?

You will need: piece of cardboard, nail, glue, clock, sunny day

- In the morning, put the cardboard in a place where the sun will shine on it all day.
- Glue the head of the nail to the edge of the cardboard as shown. Make sure this edge always faces south.
- Every hour, trace the shadow made by the nail. Write the time next to each tracing.
- Look at the sundial on another sunny day.

What time was it when you looked at the sundial? How do you know? How does a sundial work?



A Second Look

1. What is the sun?
2. What are some ways the sun is important?
3. How can you find directions by using the sun?

Teaching helps for "Finding Out": *Processes used:* observing, using numbers, communicating, inferring. *Sample findings:* When looking at the sundial on another sunny day, the pupils will most likely find that the sun shines on the nail so that a shadow of the nail falls on the cardboard near a number which corresponds to the number of the hour at that time. The pupils may infer that a sundial works in this way because the sun shines from different parts of the sky at different times during a day.

Sample answers for "A Second Look": 1. The sun is a medium-sized star. 2. The sun gives off heat and light and may help people find directions and tell time. 3. If you look toward the sun in the morning, you know you are facing east. If you look toward the sun in the afternoon, you know you are facing west.

3 The planets

When you look at the sky on a clear night, almost everything you see may look like a star. But many of these things may not be stars at all. Some of them may be *planets*. What are planets?1 How might you know planets from stars?2

Sometimes a planet may be seen in the daytime. How do you think the telescope helps this boy see a planet better?

Stars or planets?

Though planets may look like stars, they are very different from stars. One way planets are different is that they are made up of solids such as rocks and dust. Because of this, planets do not give off their own light. You can see planets only when light from the sun shines on them.

Another way planets are different from stars is that they are many times smaller than most stars. Why do you think planets look as if they are about the same size as stars? 3

[1] **Sample answer:** Planets are solid bodies in the sky that do not give off their own light.

[2] **Sample answer:** By their position in the sky. Planets would not always be found next to the same stars and planets because they move around the sun.

[3] **Sample answer:** Because they are closer to the earth than many stars are.

Main concepts of the chapter (pages 257–271):

Planets are bodies that move around the sun and are seen because sunlight shines on them.

Nighttime and daytime are caused by the earth turning around its axis.

The earth leans as it goes around the sun, causing weather changes on the earth.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

—explain what a planet is;

—show how nighttime and daytime are caused;

—explain why the weather changes on some parts of the earth from season to season.

Important words: planet, axis, earth, day, year, Mercury, Venus, craters, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

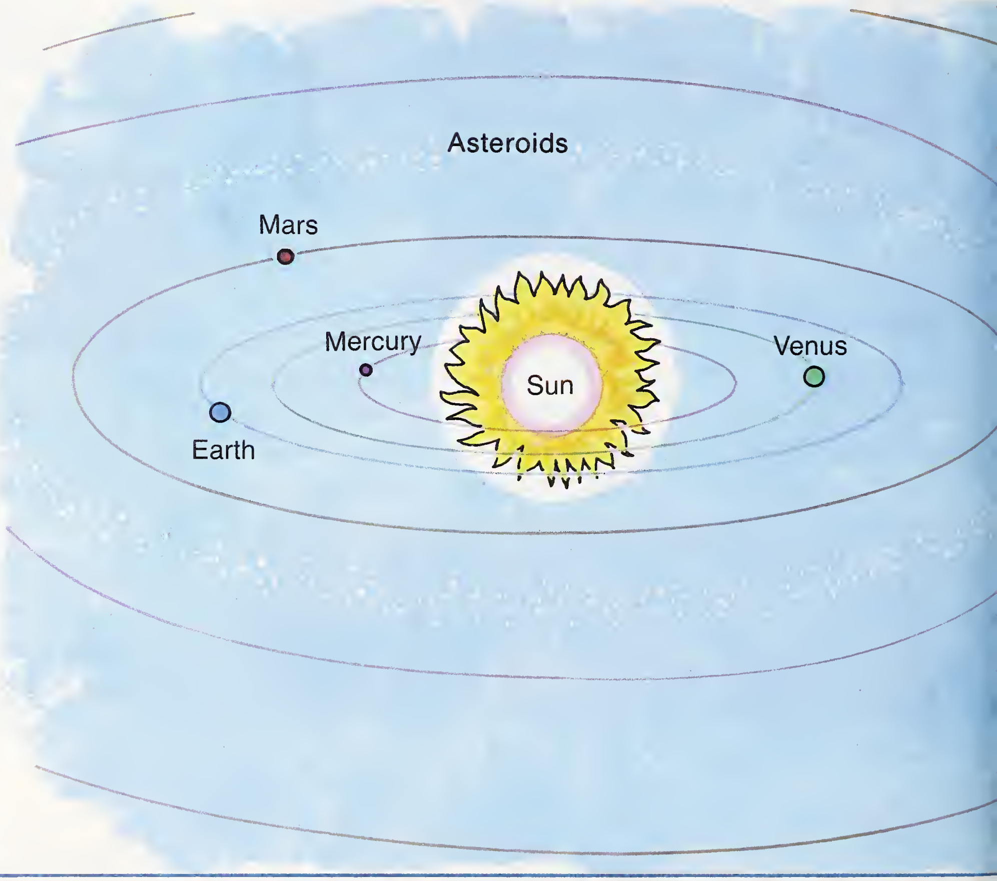
Sample answer for the caption: It makes the planet look closer than it does without the telescope.

Planets are also different from stars in that planets move around the sun. So, they are not always found next to the same planets or stars. Do you think you could see planets at any time of the year? Why or why not? 1

[1] **Sample answers:** No. Because planets move around the sun and are not near the earth during much of the year.

How planets move

There are nine planets known to be moving around the sun. Each planet moves in an egg-

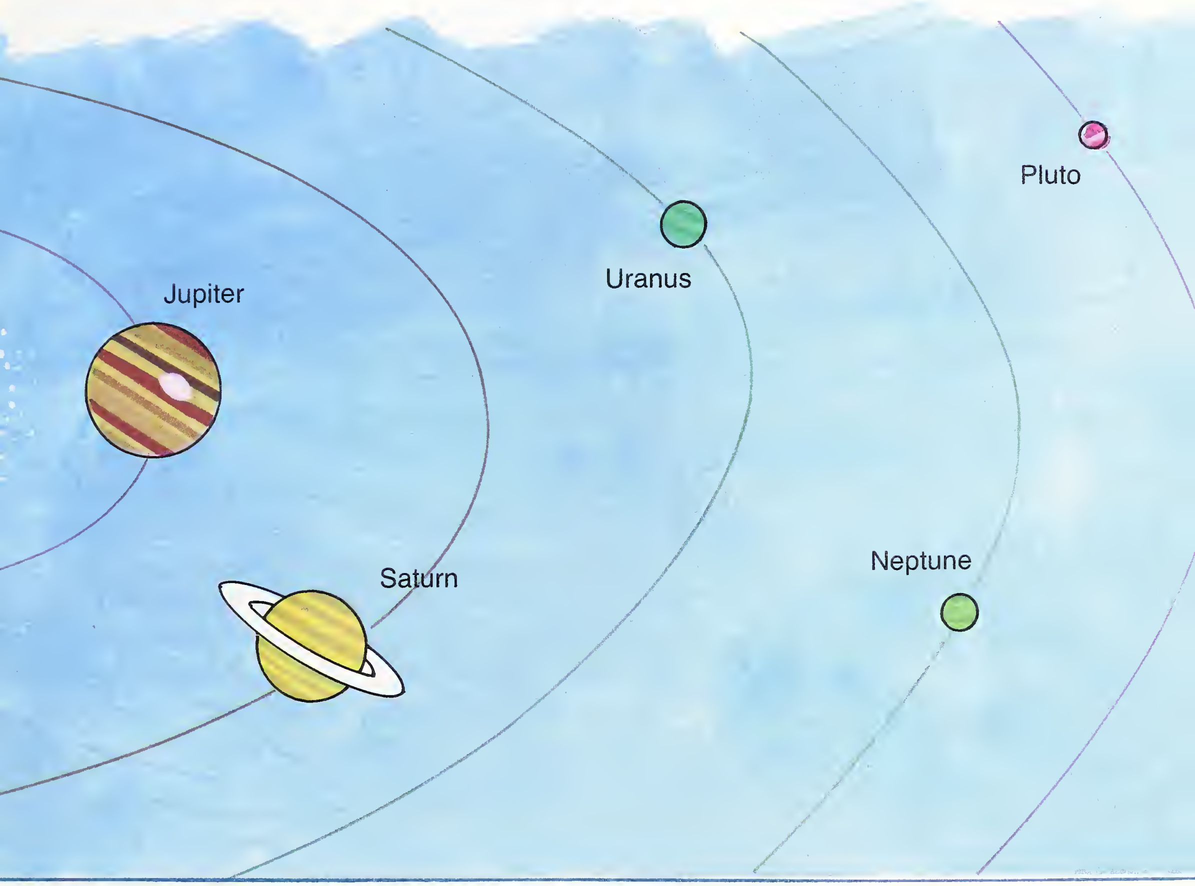


Suggested activity: After discussing "How planets move," you may wish to involve the pupils in an activity which would help them understand more about the planets. Have the pupils construct a model of the solar system. They may do this by making planets out of cardboard. To show the relative sizes of the planets, have the pupils make the diameter of the planets as follows: Mercury and Pluto, 3 mm; Venus and Earth, 8 mm; Mars, 5 mm; Jupiter, 86 mm; Saturn, 70 mm; Uranus and Neptune, 28 mm; Sun, 80 cm. To show the relative distance between the planets and the sun, have the pupils place their planets on the floor the following distances from the sun: Mercury, 23 mm; Venus, 40 mm; Mars, 90 mm; Earth, 62 mm; Jupiter, 31 cm; Saturn, 55 cm; Uranus, 112 cm; Neptune, 175 cm; Pluto, 228 cm.

shaped path. The picture below shows these planets and their path.

As each planet moves around the sun, it also moves in another way. It turns around its *axis* [AK-suhs]. The axis is a make-believe line which goes through the middle of a planet. A planet turning around its axis moves much like a toy top when the top is spinning. What do you think would happen to a planet if it did not turn around its axis?[1]

[1] **Sample answer:** One side would be very warm and one side would be very cold, and if living things were on the planet, they would most likely die because it would probably be too cold or too hot.



Suggested activity: After discussing "How planets move," you may wish to involve the pupils in an activity which would help them discover the shape of the path each planet moves in. First, have the pupils stick two pins in a piece of heavy cardboard. The pins should be about 25 cm apart. Then have the pupils make a loop of string by tying together two 25 cm pieces of string. This loop should be placed over the pins. After the loop is in place, have the pupils try to draw a circle within the loop by keeping their pencils touching the string. The pupils should find that their circle looks like an oval or an ellipse. This shape is the true shape of the orbit of each planet.

FINDING OUT

What would happen if a planet stopped moving around the sun?

You will need: about 1 m of string, small rubber ball

- Tie one end of the string tightly to the ball. (The ball may be thought of as a planet.)
- Hold the other end of the string. Swing the "planet" in a circle as shown. Do this 3 or 4 times. Make sure you stand so that you will not hit anything with the "planet."

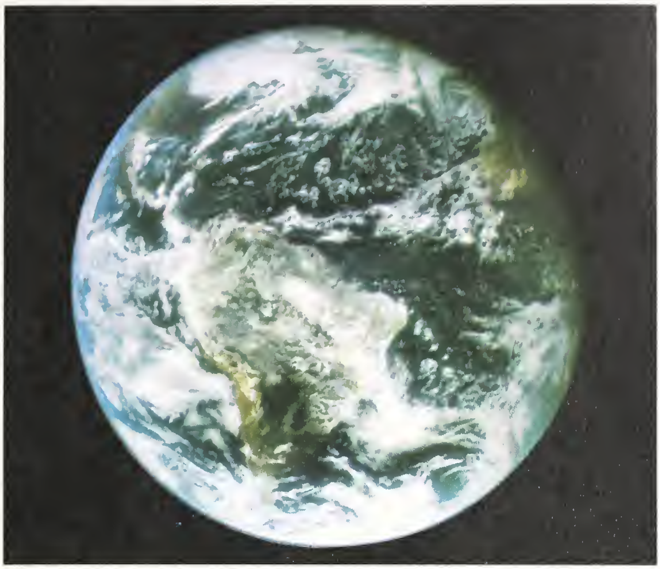
What happened to the "planet" when you swung it? What happened when you stopped swinging it?

The earth is a planet

Along with being different from stars, planets are different from one another. One planet is very different from the other planets. This planet is the *earth*. What do you think makes the earth different from the other planets?[1]

[1] **Sample answer:** It has water and air. It has living things.

Teaching helps for "Finding Out":
Processes used: observing, communicating.
Sample findings: The pupils will most likely find that the "planet" goes around in a circle as they swing it. They may also notice that the "planet" seems to tug outward from their hand. Then when the pupils stop swinging the "planet," they will probably see that the "planet" falls down toward the ground.
Additional information: One explanation of why planets travel in an orbit has to do with gravity and centrifugal force. Gravity is a force which pulls things toward other things. Centrifugal force pulls things away from things. In the case of the planets, the sun's gravitational force pulls the planets toward the sun and the planets' centrifugal force pulls them away from the sun. Because the forces are balanced, the planets stay in their orbit.



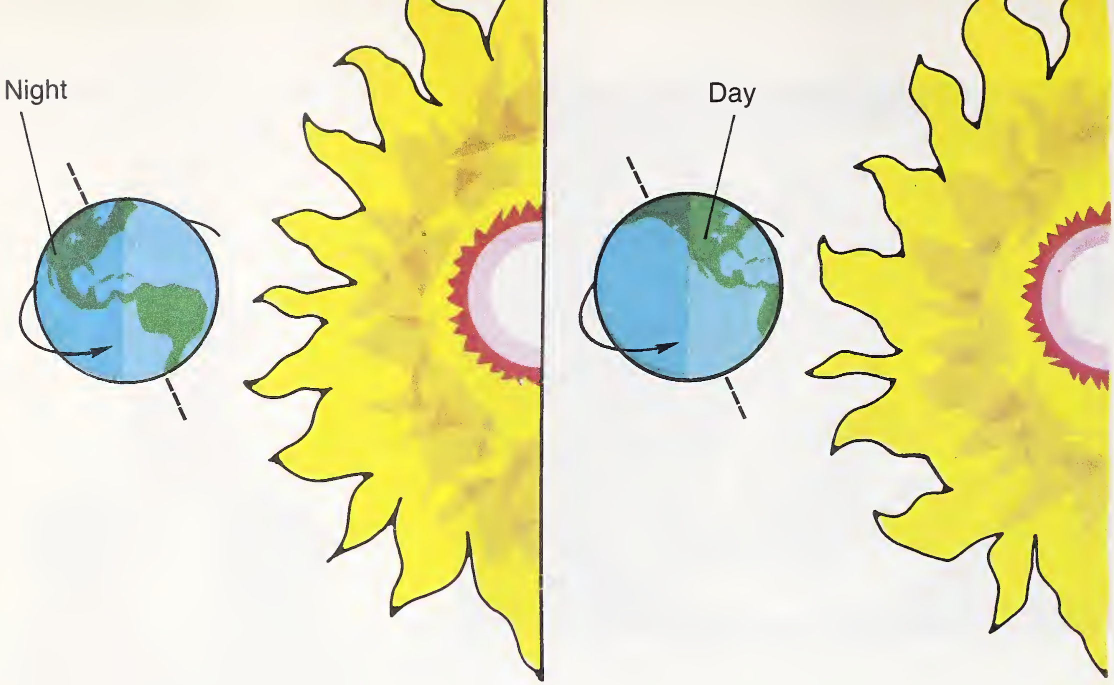
What are some of the parts of the earth you can see in this picture taken from space?

Living things. There are many ways the earth is different from the other planets. One of the most important of these is that only the earth is known to have living things. What are some things about the earth that make it a good place for living things?[1]

[1] **Sample answer:** It has air, water, and the right amount of sunlight.

Daytime and nighttime. Another way the earth is different from other planets is in the time it takes to move around its axis. The earth takes twenty-four hours to make one turn around its axis. The time it takes a planet to make one turn around its axis is called a *day*. The table on page 263 shows how long a day is on each planet.

Sample answer for the caption: South America, parts of North America, Africa, Europe, clouds, water.



As you probably know, a day on the earth is made up of daytime and nighttime. The pictures on this page show what causes daytime and nighttime.

About how much of a day on the earth is daytime?[1] About how much is nighttime?[2]

[1] **Sample answer:** 12 hours.

[2] **Sample answer:** 12 hours.

Years and seasons. The earth is different from other planets in still another way. That way is in the time it takes to move around the sun. The earth takes about 365 days to make one trip around the sun. The time it takes a planet to make one trip around the sun is called a *year*. The table on page 263 shows how long a year is on each planet.

Suggested discussion: After discussing "Daytime and nighttime" on pages 260 and 261, you may wish to point out to the pupils that some days during a year have more daytime than nighttime and some days have more nighttime than daytime. You might then have the pupils find out why this is so by looking in reference books under the headings *day* and *season*.

FINDING OUT

How can you show what causes day and night?

You will need: globe of the earth, small piece of paper, tape, bright light, dark room

- Shine the light on the globe. (The light may be thought of as the sun.)
- Find where you live on the globe. Tape the paper to this spot on the globe.
- Turn the globe slowly from west to east, or counterclockwise. Turn the globe one full turn.

What happened to the part of the earth where you live? Why?

Length of Days and Years on the Planets

Planet	Day *in earth-days or earth-hours*	Year *in earth-days*
Mercury	59 days	88
Venus	243 days	225
Earth	24 hours	365
Mars	24 hours	687
Jupiter	10 hours	4333
Saturn	10 hours	10 759
Uranus	11 hours	30 685
Neptune	15 hours	60 188
Pluto	6 days	90 700

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: As the pupils turn the globe, they will most likely see that the part of the earth where they live is in sunlight for half of a turn and in darkness for half of a turn. The pupils will probably infer that all the earth cannot be lighted by the sun all the time.

[1] **Sample answer:** It gets cooler in the winter and warmer in the summer. It may snow or rain more in the winter than in the summer.

[2] **Sample answer:** The earth's tilt as the earth moves around the sun.

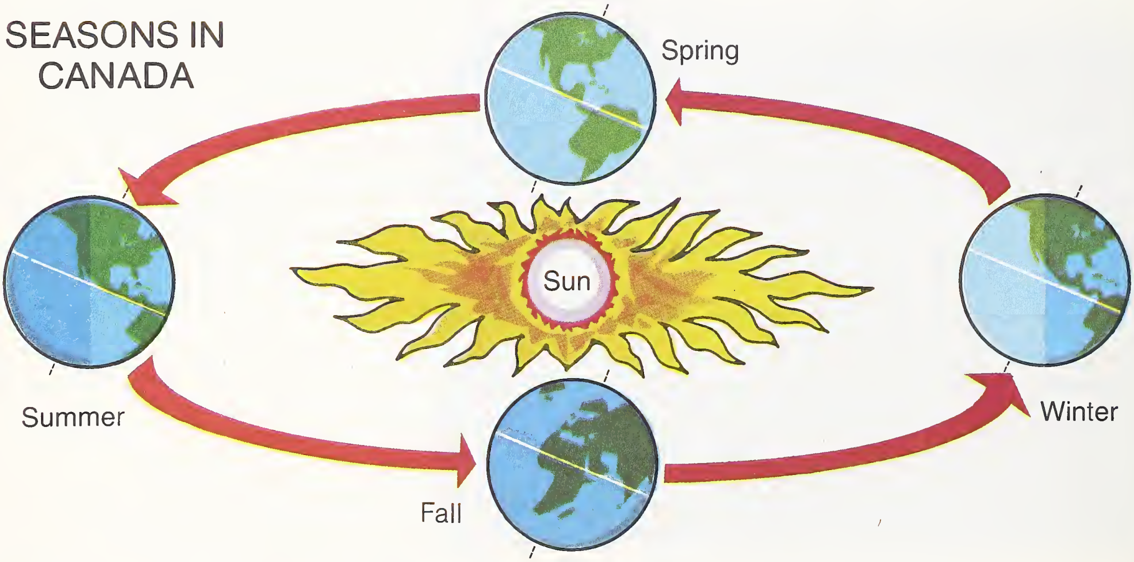
For You to Think About

What would happen on the earth if the earth's axis were not leaning? What would happen if the axis were leaning in the opposite direction?

As you probably know, a year on the earth is made up of four seasons. And as the seasons change, the weather changes on some parts of the earth. In what ways does the weather change from season to season?[1] What causes the weather to change?[2]

The earth's axis is always leaning in the same way as the earth moves around the sun. Therefore, different parts of the earth lean toward the sun at different times. When the top part of the earth leans toward the sun, it gets more sunlight than the bottom part. At this time the top part has warm weather. It is said to have summer. When the top part of the earth leans away from the sun, it gets less sunlight than the bottom part. At this time the top part has cool weather. It is said to have winter. When does

SEASONS IN CANADA



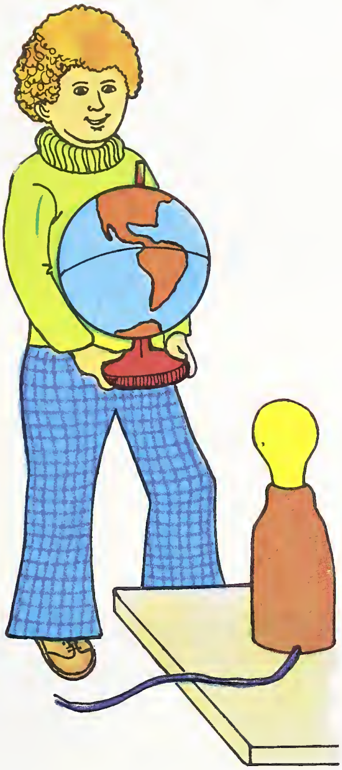
Sample answers for "For You to Think About": There would be very little change in weather from season to season. The months during which the seasons normally occur would reverse. For example, during December, January, and February when the top half of the earth normally has winter, the top half would have summer.

the bottom part of the earth have summer and winter?[1]

On the middle part of the earth the weather changes very little during a year. Why?[2] Does the weather where you live change during a year? If so, in what ways?

[1] **Sample answer:** The bottom half has summer when the top half has winter. The bottom half has winter when the top half has summer.

[2] **Sample answer:** Because this part of the earth stays about the same distance from the sun. The middle part does not lean much either toward or away from the sun.



FINDING OUT

How can you show what causes seasons?

You will need: lamp without a shade, table, globe of the earth

- Put the lamp on the table. Plug the cord into an electric socket. Turn on the lamp. (The lamp may be thought of as the sun.)
- Hold the globe about 1 m away from the lamp. Make sure that the globe leans as shown.

What part of the earth has summer? Why? What part has winter? Why?

- Carry the globe in a circle halfway around the "sun." Always keep the top of the globe pointing toward the same wall.

Now what part of the earth has summer? Why? What part has winter? Why?
Where would the earth be when the top part has spring? Where would the earth be when this part has fall?

Teaching helps for "Finding Out":
Processes used: observing, inferring, predicting.
Sample findings: First, the pupils will most likely find that the bottom part of the earth has summer and the top part of the earth has winter. They may infer that the reason for this is that the bottom part of the earth is leaning toward the "sun" and therefore is warm and the top part is leaning away from the "sun" and is cool. After the pupils carry the globe halfway around the "sun," they will most likely find that the bottom part of the earth has winter and the top part has summer, because the top is leaning toward the "sun" more than the bottom part and is therefore warmer. When the top part has spring, the earth would be halfway between the point at which it leaned away from the "sun" and the point at which it leaned toward the "sun." When the top part has fall, the earth would be halfway around the "sun" from the point at which it had spring.

Other planets

For many years, little was known about any planet other than the earth. After the telescope was invented, people started to learn many things about other planets.

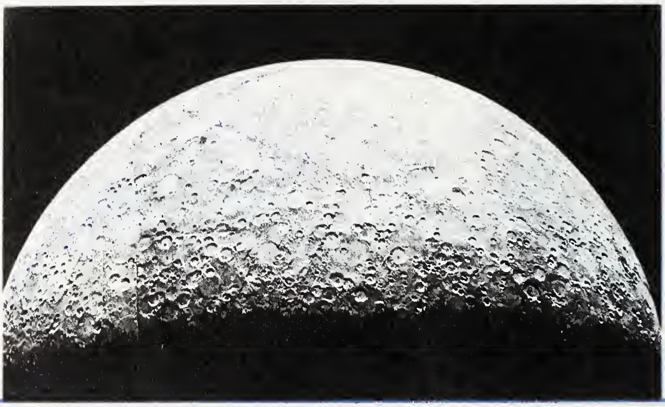
Along with using telescopes, people today use spaceships to learn about the other planets. A spaceship may be sent close to a planet. Then it sends information about this planet to the earth. Some of this information may be in the form of pictures. What might you learn from a picture of a planet?[1]

[1] **Sample answer:** If there is water or mountains on it. If there are living things on it.

Mercury. As you may know, the planet *Mercury* [MUR-kyuh-ree] is the closest planet to the sun. Because of this, Mercury is often hard to see from the earth. However, pictures from a spaceship have shown that this planet is covered with *craters,* or bowl-shaped holes. Such craters are often made by large rocks which fall from the sky.

It has also been learned that Mercury has some of the same gases that are found in the air on the earth. What might it be like to live on Mercury?[2]

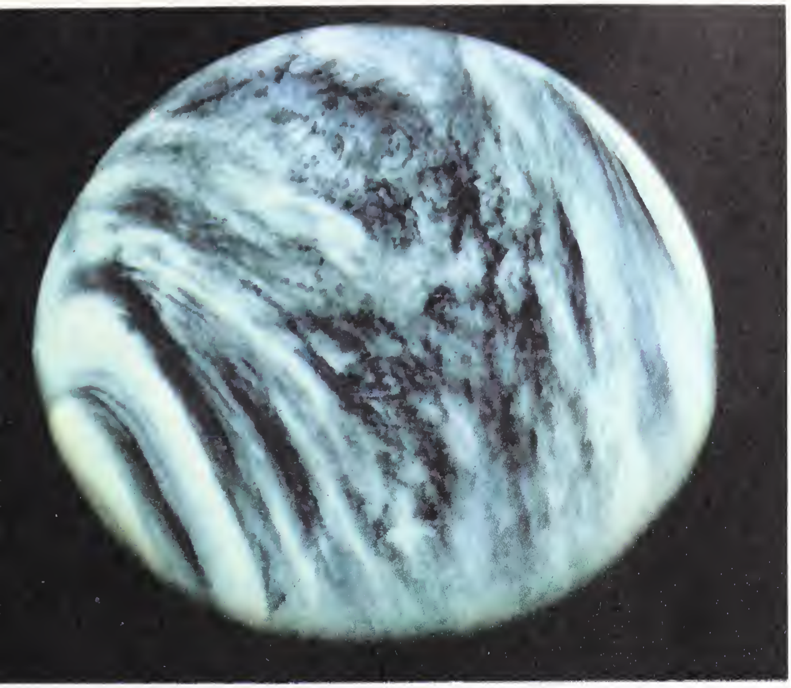
[2] **Sample answer:** It would be too hot to live outdoors. It would not be very pretty because it has no colourful things such as plants and animals.



This picture of Mercury is made up of a number of smaller photographs taken from a spaceship. Why do you think the picture had to be made in this way?

Sample answer for the caption: To get a close-up view of one whole side of the planet while the spaceship was moving.

Suggested research: After discussing "Mercury," you may wish to have the pupils find out why rocks from space fall and cause craters. The pupils may do this by looking in reference books under the headings *craters* and *meteorites*. Have the pupils report their findings to the class.



Venus. The planet that moves in a path between Mercury and the earth is *Venus* [VEE-nuhs]. Venus is about as big as the earth. Next to the moon, Venus is the brightest thing you can see in the sky on some nights. Why do you think this is so?[1]

It has been found that a thick layer of clouds covers Venus. However, it is thought that this planet has deserts and mountains as does the earth. It is also thought that Venus has very little water or oxygen. Do you think anything could live on Venus? Why or why not?[2]

[1] **Sample answer:** Because it is very close to the earth.

Exploring on Your Own

Venus is often called the *morning star* and the *evening star*. See if you can find out why.

[2] **Sample answers:** No. Venus has too little water and oxygen and is too hot for living things that I know of.

Sample findings for "Exploring on Your Own": At certain times during a year, Venus is the last star or planet to be seen in the eastern sky before sunrise. At other times during a year, Venus is the first star or planet to be seen in the western sky after sunset. Before planets were discovered to be different from stars, ancient astronomers thought that Venus was two different stars. The astronomers named Venus the morning star and the evening star.

Suggested research: After discussing "Mercury" on page 266 and "Venus" on page 267, you may wish to point out to the pupils that spacecraft have passed close to several planets, and some spacecraft have landed on planets. You might want pupils to find out what these spacecraft have found out about Mercury, Mars and Venus. Have the pupils look in reference books under *space exploration, Mercury, Mars* and *Venus.*

Mars. There is another planet that can be seen easily from the earth. This planet is *Mars*.

If you were to look at Mars through a telescope, you would see that this planet looks like a red ball. Pictures of Mars have shown that this colour comes from the dust which covers most of the planet. You would also see lines on Mars. The lines were once thought to be canals which carried water. But there seems to be no water on Mars. These lines may be made up of rows of craters.

Pictures from spaceships have shown some other things about Mars. This planet has large volcanoes. It also seems to have seasons. During some seasons, the wind on Mars blows the dust every day. What might it be like to live on Mars?[1]

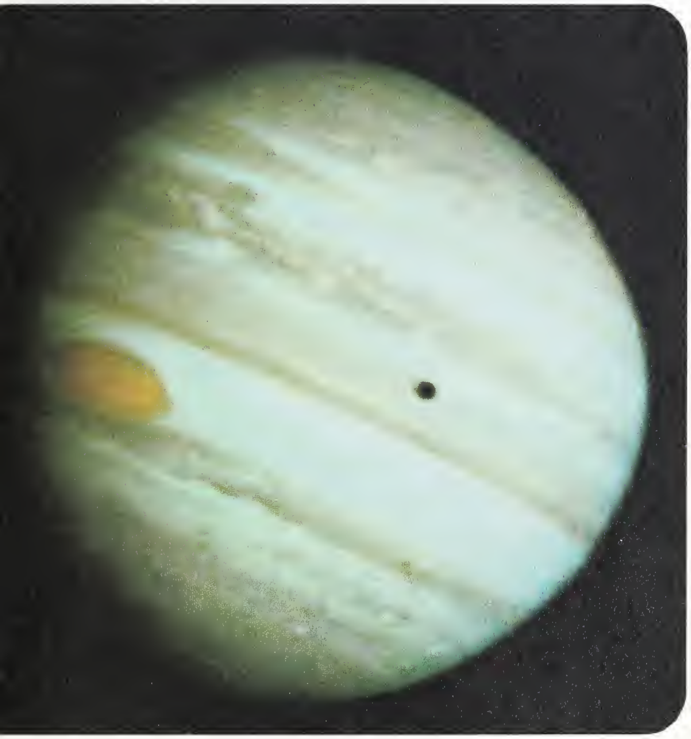
[1] **Sample answer:** It would be too cold to go outdoors. It would be interesting to see the seasons change.

Suggested research and discussion: After discussing "Mars," you may wish to point out to the pupils that much information about Mars was learned from spacecraft. You might want to have the pupils find out what information about Mars was sent to the earth by spacecraft. They may do this by looking in reference books under the heading *space exploration*. Then you may wish to ask the question: Why might people want to learn more about a planet such as Mars? (Sample answer: Because it is thought that some planets which are close to the earth such as Venus and Mars may have had living things millions of years ago, and learning about the environment of these planets and changes on these planets today might help people understand the earth's environment and changes.)

Jupiter. The largest planet known is *Jupiter* [JOO-puht-ur]. This planet is ten times as big as the earth. Like most planets, Jupiter seems to have no water or oxygen. But this planet may have some gases which are poisonous.

If you look at the picture below, you can see that Jupiter has a red spot. This spot moves each year. You may also see light lines and dark lines. These lines also move. It is not known what the spot and lines are. However, it is thought that the lines are made up of gases. What might the spot be made of?[1]

[1] **Sample answer:** It is thought that this spot is also made up of gases.



The small, black dot in this picture is the shadow of one of Jupiter's moons. What other planets do you know of that have moons?

Sample answer for the caption: Mars has two moons. Jupiter has thirteen moons. Saturn has ten moons. Uranus has five moons. Neptune has two moons.

Suggested research: After discussing "Jupiter," you may wish to point out to the pupils that spacecraft have passed Jupiter. You might then have the pupils find out more about these spacecraft by looking in reference books under the headings *space exploration.*

Saturn. Like Jupiter, the planet *Saturn* seems to have poisonous gases. Saturn also has no water or oxygen. However, there is one thing that makes Saturn different from Jupiter and all the other planets. Saturn has three thin rings around it. These rings are thought to be made up of small pieces of ice. What do you think it would be like to live on Saturn? [1]

[1] **Sample answer:** It would be too cold to go outdoors, but it would be interesting to see the rings around Saturn from the planet instead of from the earth.

Uranus, Neptune, and Pluto. There are three other planets that move around the sun. These planets are so far away that they can be seen only with a telescope. These planets are *Uranus* [yu-RAY-nuhs], *Neptune* [NEHP-T(Y)OON], and *Pluto* [PLOOT-oh].

Suggested research: After discussing the material on this page, you may wish to point out to the pupils that the planets were named after gods in ancient stories. You might want to have pupils read about these gods and their importance to people long ago. Have the pupils look in reference books under the heading *mythology*.

Little is known about these planets. But it is hoped that someday spaceships will send information about these planets to the earth. What do you think these planets might be like? Why?[1]

A Second Look

1. What is a planet and how is it different from a star?
2. In what ways do planets move?
3. What are days? Why are days longer on some planets than on others?
4. What causes the weather to change on some parts of the earth from season to season?

Exploring on Your Own

As was said in this chapter, many things have been learned about planets because of spaceships. Try to find out what other things have been learned about planets in this way. You may do this by looking in reference books under the heading *space travel*.

[1] **Sample answers:** Very cold with no water or oxygen. Because they are far away from the sun.

Sample finding for "Exploring on Your Own": Spaceships have sent information to the earth about the temperature and gravity of some planets.

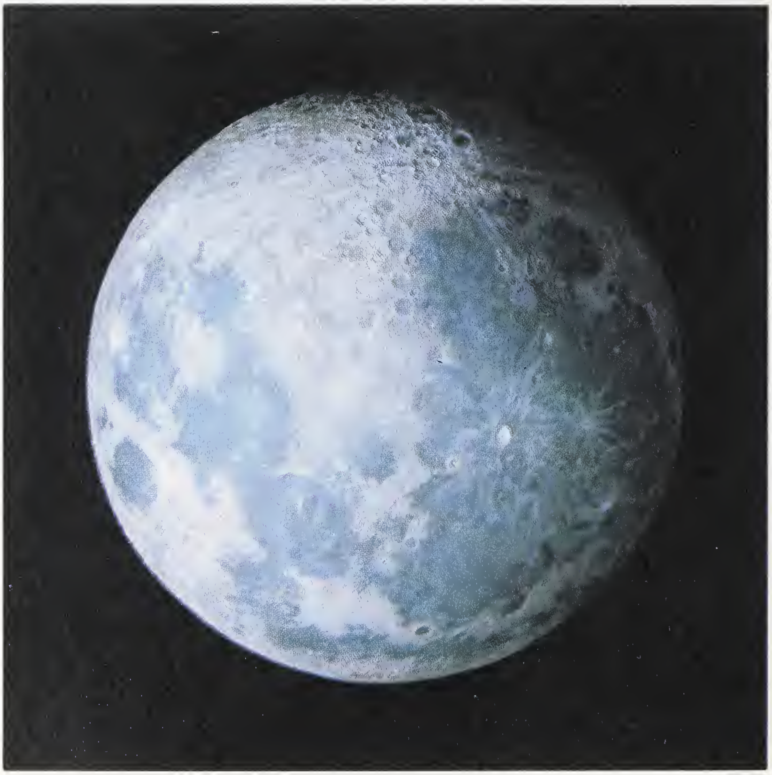
Sample answers for "A Second Look": 1. Planets are solid bodies in the sky which do not give off their own light and can be seen only when the sun shines on them. Stars give off their own light and are many times bigger than planets. 2. Planets move around the sun and turn on their own axis. 3. A day is the time it takes a planet to make one turn around its axis. Some planets take longer to turn around their axis than others. 4. The movement of the earth around the sun, and the leaning of the earth's axis.

4 The moon

Have you ever looked at the moon carefully? If you have, you may have seen that some parts of it are darker than other parts. To many people, these dark parts seem to form a face on the moon. To other people, these parts seem to form a rabbit. Still other people have said that the dark parts of the moon seem to form two people.

What do these dark parts look like to you? What do you think the dark parts are made of? [1]

[1] **Sample answer:** Flat places made of dust between mountains.



Main concepts of the chapter (pages 272–277):

The moon is more like other planets than like the earth.

The moon is closer to the earth than any star or planet is.

The moon seems to change shape because it travels around the earth.

There is a side of the moon that is never seen from the earth.

Performance objectives: After studying the information provided in this chapter, the pupils should be able to

- —give three reasons why the moon is more like other planets than like the earth;
- —demonstrate why the moon seems to change shape;
- —explain why there is a side of the moon that is never seen.

Important words: moon, eclipse.

What does this lunar rover show about the moon in this picture? How else might such a "buggy" be helpful on the moon?

What is the moon?

Long ago, it was thought that the stars, planets, and moon moved around the earth. But today it is known that only the moon moves around the earth. Why do you think people thought that the stars and planets moved around the earth?[1]

The moon is closer to the earth than any star or planet. Even so, the moon is different from the earth. In fact, the moon is more like many of the other planets than like the earth. For example, the moon has no wind, air, or water. The moon is made up of dust and rocks. Some of these rocks are older than any rocks found on the earth. Do you think things on the moon change much from year to year? Why or why not?[2]

[1] **Sample answer:** Because the stars and planets look as if they move, and until another reason is given to people, they usually believe what they see.

[2] **Sample answers:** No. Because without wind or water to move things and wear things away or without people to build things, the only way the moon might be changed is by rocks and other things from the sky hitting it.

Exploring on Your Own

Much of what people know about the moon has been learned because people have traveled to the moon. Try to find out what things have been learned from these travels. You may do this by looking in reference books under the headings *moon* and *space travel*.

Sample answers for the caption: That the moon is dusty. The lunar rover was helpful to the astronauts because it allowed them to travel and explore places several kilometres away from the space module they landed in.

Sample findings for "Exploring on Your Own": That the moon is made up of dust and rocks. Many of the craters on the moon were made billions of years ago. There were probably volcanoes which erupted billions of years ago.

Suggested discussion: After discussing the material on pages 272 and 273, you may wish to point out to the pupils that the moon's surface can be seen more clearly from the earth than the surface of any other body in the sky can be seen. You might then ask the pupils why they think this is so. (Sample answer: Because the moon is closer to the earth than any other body is and the moon has no wind, air, or water to form clouds to cover its surface.)

Many parts of the moon have mountains. Other parts have flat places. These flat places are the dark parts that you see from the earth. But most of the moon is covered with craters. If the moon has mountains and craters, why does it look smooth from the earth?[1]

Seeing different shapes

If someone asked you to draw a picture of the moon, what would you draw? Would you draw a white ball? That is what many people would do. But the moon does not always look like a ball. Sometimes the moon looks like a thin, curved line. What does the moon look like at other times?[2] Why does the moon seem to change shape?[3]

As was said before, the moon moves around the earth. The pictures on the next page show the moon as it makes this trip. As you may see, the sun lights only one half of the moon at a time. Can you always see this lighted half of the moon from the earth? Why or why not?[4]

Seeing only one side

You may have seen a full moon many times. But have you ever noticed that it always looks the same? There is a side of the moon that you never see from the earth. Why do you think this is so?[5]

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[1] **Sample answer:** Because it is so far away.

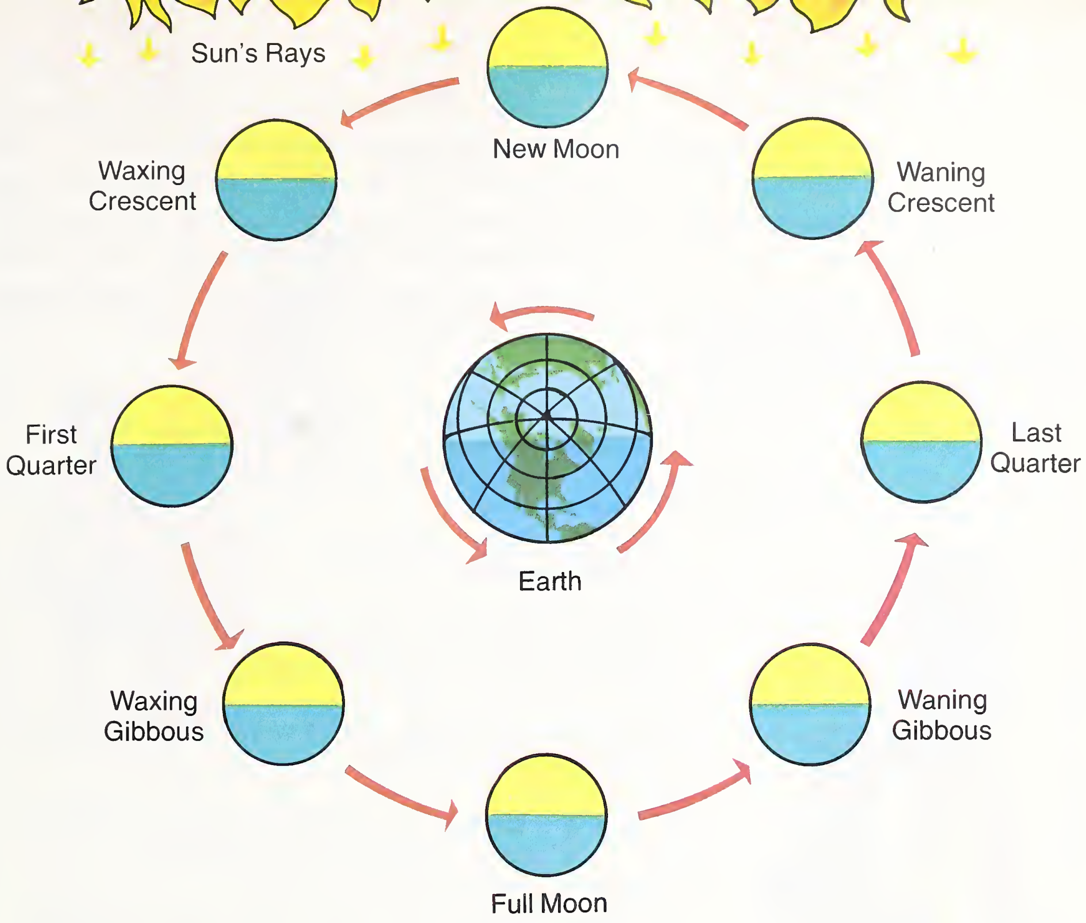
[2] **Sample answer:** Half a ball, a ball with a part missing.

[3] **Sample answer:** Because the moon is traveling around the earth and we may see only part of the lighted side of the moon.

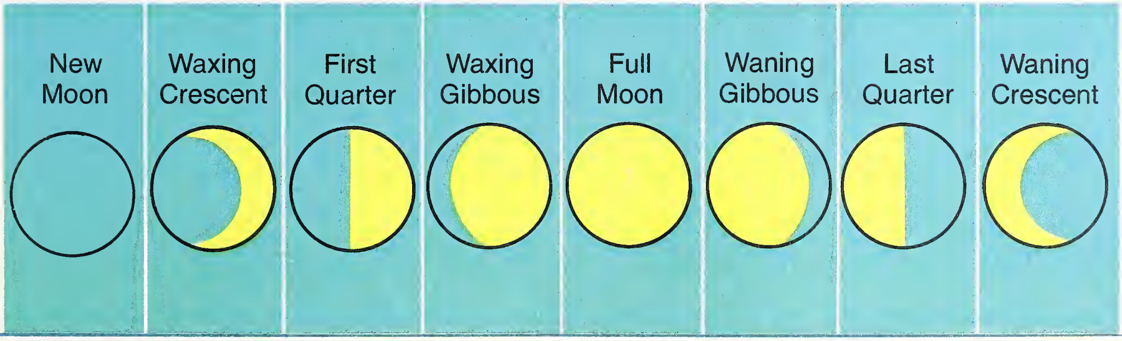
[4] **Sample answers:** No. Because it does not always face the earth.

[5] **Sample answer:** Because the moon takes as long to go around the earth as it does to go around its axis.

Suggested activity: After discussing "Seeing different shapes," you may wish to involve the pupils in an activity which would help them see that the moon seems to change shape. Have the pupils keep a record of the moon for a month. They may do this by looking at the sky every day to find the moon, by drawing a picture of what they see, and by writing down the time they saw the moon and where in the sky they saw it.



If you were above the moon, the earth, and the sun, this is how they would look as the moon travels around the earth. The moon takes about four days to move from one position to the next. The pictures below show how the moon looks in each of these positions as you see it from the earth.

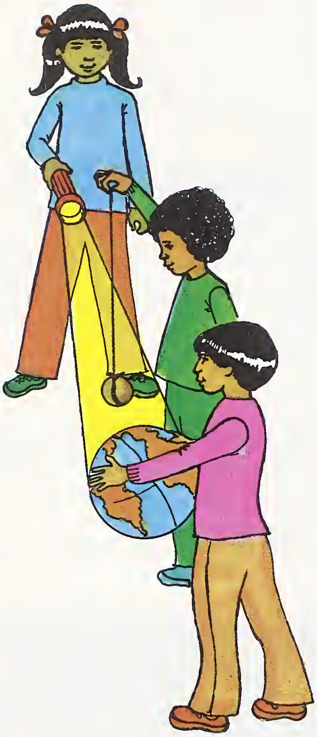


Suggested activity: After discussing the pictures above, you may wish to involve the pupils in an activity which would help them understand further why the moon seems to have different shapes. Have the pupils work in groups of three. One pupil will be the earth; one pupil will hold a large rubber ball, which will be the moon; and one pupil will hold a flashlight, which will be the sun. Have the pupils line up so that the "earth" is in the middle and the "sun" can shine on the "moon." Then have the pupil holding the "moon" walk in a circle around the "earth" with the "sun" always pointed at the "moon" and the "earth" always watching the "moon." The pupils may want to take turns being the "earth" so that they may see each of the stages shown in the pictures on this page.

Like the planets, the moon turns around an axis. It takes the moon about thirty days to turn one time around its axis. This time is the same as the time the moon takes to move around the earth. Because of this, the same side of the moon always faces the earth. What would happen if the moon did not turn on its axis?[1]

[1] **Sample answer:** We would be able to see both sides of the moon as it traveled around the earth.

FINDING OUT



What happens when the moon passes directly between the sun and the earth?

You will need: flashlight, globe of the earth, tennis ball, piece of string, dark room

- Tie the string to the tennis ball. (The tennis ball may be thought of as the moon.)
- Have someone hold the globe.
- Have someone else stand away from the globe and shine the flashlight on the globe. (The flashlight may be thought of as the sun.)
- Hold the string so that the "moon" is directly between the "sun" and the earth. Make sure that the "moon" is closer to the earth than the sun as shown. When the earth, sun, and moon are lined up in this way, an *eclipse* of the sun comes about.

What happened on the earth during your "eclipse"?

Teaching helps for "Finding Out":
Processes used: observing, communicating.
Sample findings: When the pupils line up the "earth," "sun," and "moon" for an eclipse of the sun, the pupils will most likely state that the "moon" blocks most of the light from the "sun" so that the whole "sun" cannot be seen.
Additional information: You might want to point out to the pupils that looking at a real eclipse of the sun can cause eye damge. You may find reference books helpful in showing how to view an eclipse safely.
Extending the "Finding Out": Sometimes during a full moon, an eclipse of the moon takes place. Have the pupils show what causes such an eclipse by lining up the "sun," "moon," and "earth" as they did for the eclipse of the sun. Then have the pupil holding the "moon" move it slowly around the "earth" until the "earth" keeps the "sunlight" from shining on the "moon."

FINDING OUT

How can you show why you see only one side of the moon?

You will need: room with an empty space

- Have someone stand in the middle of the empty part of the room. (This person may be thought of as the earth.)
- Have someone else stand about 2 or 3 m away from the "earth." (This person may be thought of as the moon.)
- Have the "moon" walk sideways in a circle around the "earth." Make sure that the "moon" is always facing the "earth."

Did the "moon" turn around its axis as it moved? Why can you see only one side of the moon from the earth?

A Second Look

1. In what ways is the moon different from the earth?
2. What makes up the dark parts of the moon that you see from the earth?
3. Why does the moon seem to change shape?
4. Why does the same side of the moon always face the earth?

Teaching helps for "Finding Out":
Processes used: observing, inferring.
Sample findings: The pupils will most likely see that the moon does turn around its axis as it moves around the earth. From this, the pupils may infer that they can see only one side of the moon from the earth because the moon takes as long to turn around its axis as it does to travel around the earth.
Sample answers for "A Second Look": 1. The moon has no wind, air, or water, and takes about thirty days to turn around its axis one time. The earth has wind, air, and water, and takes about twenty-four hours to turn around its axis. 2. The dark parts of the moon are made up of flat places. 3. At times as the moon moves around the earth, the earth blocks light from the sun so that it cannot shine on the moon fully. 4. The moon takes about the same amount of time to turn around its axis as it takes to move around the earth.

Workers Who Use Science

For thousands of years, people have had questions about the stars, planets, and moon. For examples, What are the planets and moon made of? Will the sun ever stop shining? Many people are working to find answers to these questions. Some of these people are called *astronomers* [uh-STRON-uh-murz].

Astronomers are trying to find answers to still other questions. For instance, Is there life on planets other than the earth? To find out, astronomers study information from spaceships. They also study the planets with telescopes.

Along with studying the stars, planets, and moon, many astronomers do something else. They teach other people, such as *astronauts* [AS-truh-NAWTS], what is known about the stars, planets, and moon.

To find out more about the work of astronomers, try to find answers to these questions:

How might information that astronomers find be helpful to other people?[1]

Besides spaceships and telescopes, what are some things astronomers use to study the stars, planets, and moon?[2]

Along with sources of your own, writing to the following source may help you: The Royal Astronomical Society of Canada, 252 College Street, Toronto, Ontario M5T 1R7.

This astronomer is getting ready to take pictures of the sky through a large telescope. Why might such pictures be important?

Sample answer for the caption: Because looking at pictures of stars and other things seen in the sky is easier than looking at these things through a telescope. Because pictures make a permanent record of something that may change.

[1] **Sample answer:** Astronomers help astronauts and other people involved with spacecraft know how far away the moon and the planets are and what the moon and the planets are like so that the spacecraft can travel to them safely.

[2] **Sample answer:** Spectrographs, optical recording equipment, radio telescopes.

Reviewing the Main Ideas

A star is made up of hot gases which give off light.
The colour of a star depends on how hot it is.
Stars seem to move because the earth is turning.
The sun is a medium-sized star.
The sun is important to the earth because it gives off heat and light. The sun may also help people find directions and tell time.
Planets can be seen only when light from the sun shines on them.
Planets move around the sun. They also turn around their axis.
The earth is the only planet known to have living things.
Nighttime and daytime are caused by the earth turning around its axis.
People use telescopes and spaceships to learn about other planets.
The moon is more like other planets than like the earth.

Reading About Science

Asimov, Isaac. *The Solar System.* Scarborough, Ontario: McGraw-Hill Ryerson Limited, 1975.
Ryan, Peter and Pesek, Ludek. *Journey to the Planets.* Markham, Ontario: Penguin Books Canada Limited, 1973.
Smith, Norman. *Space: What's Out There?* Don Mills, Ontario: Longman Canada Limited, 1976.

Reviewing the unit: You may wish to have the pupils study "Reviewing the Main Ideas" to help prepare for "Testing for Understanding" on page 280.

For further reading: You may wish to encourage the pupils to read the books listed under "Reading About Science" and other books and articles related to the topic of the sky. Such articles might be found in reference books under the headings *gravity, asteroids, comets, meteors,* and *galaxy.*

Testing for Understanding

Ideas to Check

On your paper write *T* for each sentence below that is true. Write *F* for each sentence that is false.

F 1. The sun is a planet.
T 2. Stars seem to move because the earth turns around its axis.
T 3. The earth is the only planet known to have living things.
T 4. The moon moves around the earth.
T 5. The earth and the other planets move around the sun.
F 6. Stars can be seen only when light from the sun shines on them.

Words to Use

Write on your paper the word that best fits in each blank below. Choose from these words: *planets, stars, day, year, constellation, oxygen, moon, sun, Earth, Mercury, Saturn, Mars, Uranus, axis.*

1. Each planet turns around a make-believe line called its ____. axis
2. The time it takes a planet to make one turn around its axis is called a ____. day
3. ____ is the only planet that has rings around it. Saturn
4. A group of stars that makes up a picture is called a ____. constellation
5. ____ is the closest planet to the sun. Mercury

Suggestions for evaluation: You may wish to use the test questions provided under "Testing for Understanding" to evaluate the pupils' understanding of the main ideas and important words of this unit. Additional test questions for the unit "Watching the Sky" are provided for you on page T21 of the Teacher's Manual. These test questions may be duplicated for classroom use. Answers to these additional test questions can be found on page T22 of the Teacher's Manual.

Having Fun with Science

What Am I?

1. I am always turning in the sky, but you can see only one side of me.
2. I look small and bright like a star. I can be seen in the nighttime sky. But I am not a star.

Fun with Words

The names of two planets are very much alike. Move the letters of one of these planets and you can spell the name of the other planet. You must also change one letter. What are the two planets?

Things to Do

1. Make a bulletin-board display or a scrapbook about the planets or the moon. You may want to use cartoons, poems, pictures, and articles from newspapers about the planets or the moon.

2. Find out what a *planetarium* [PLAN-uh-TEHR-ee-uhm] is. Ask your teacher to help you plan a visit to a planetarium. Make a list of questions about the stars, planets, and moon. Ask someone who works in the planetarium to answer your questions.

3. Using reference books, learn the name and shape of some constellations you would like to see in the sky. Find out what time of year you can see these constellations. Try to find the constellations in the sky.

For further involvement: You may wish to use "Having Fun with Science" to involve the pupils in fun activities which reinforce some of the main concepts of the unit "Watching the Sky." You may also wish to encourage the pupils to make up additional activities related to the topic of the sky.

Answers for "What Am I?": 1. The moon. 2. A planet.

Answers for "Fun with Words": Saturn and Uranus.

Glossary-Index

One of the purposes of this glossary-index is to help you pronounce and understand certain words in this book. Another purpose is to help you find out about topics in this book that may interest you. You can find out about a topic by turning to the page or pages given at the end of each topic that is listed.

In this glossary-index, the syllables of a word are separated by a space. This can help you say the word. A special spelling may follow a word. This spelling always appears in [ ]. This spelling can also help you say the word. When a word has two or more syllables, one syllable is stressed more than others. This syllable is always spelled with large capital letters, as in the word *gravity* [GRAV-uht-ee]. Syllables that are not stressed are always spelled with small letters. Sometimes a word has one or more syllables that are stressed, but not so much as the syllable spelled with large capital letters. Those syllables are spelled with small capital letters, as in the word *electricity* [ih-LEHK-TRIHS-uht-ee]. Words of only one syllable are also spelled with small capital letters, as in the word *nerve* [NURV].

Sometimes a syllable in a special spelling is placed inside ( ), as in the word *mineral* [MIHN(-uh)-ruhl]. This means that some people say the syllable when they say the word, but some people do not.

Below is a list of the letters and letter groups used for the special spellings. Across from each letter or letter group, you can read how most people say the letter or letter group.

Letter or letter group	Say like
a	*a* in *hat* [HAT]
ah	*a* in *father* [FAHTH-ur]
aw	*a* in *all* [AWL]
ay	*a* in *face* [FAYS]
ch	*ch* in *child* [CHYLD] and in *much* [MUHCH]
ee	*e* in *equal* [EE-kwuhl]
eh	*e* in *let* [LEHT]
eye	the first *i* in *iris* [EYE-ruhs]
g	*g* in *go* [GOH]
ih	*i* in *hit* [HIHT]
o	*o* in *hot* [HOT]
oh	*o* in *open* [OH-puhn]
oo	*oo* in *food* [FOOD] and *u* in *rule* [ROOL]
ow	*ou* in *out* [OWT]
oy	*oi* in *voice* [VOYS]
s	*s* in *say* [SAY]
sh	*sh* in *she* [SHEE]
u	*u* in *put* [PUT] and *oo* in *foot* [FUT]
uh	*u* in *cup* [KUHP]
ur	*er* in *term* [TURM] and *ir* in *sir* [SUR]
y	*i* in *nice* [NYS]
z	*s* in *degrees* [dih-GREEZ]
zh	*s* in *treasure* [TREHZH-ur]

Air: and breathing, 65, 152, 161, 194; earth's layer of, 196; having weight, 197–198; and ice, 169, 172, 174; and liquids, 169, 172; makeup of, 152, 162, 173, 182, 196; moisture in, 221; moon and, 273; movement of, 162; planets and, 266; plants and, 16, 29, 182, 233, 254; pollution of, 84–85, 89; pressing down of, 198–199; and rust, 184; seeds and, 19; spores and, 13, 19; stars and, 243, 245, 253; taking up space, 161, 195–196; temperature of, 166, 202; weather and, 172, 195, 201–205, 207–211, 215, 221, 226–227, 229, 234; wind and, 160, 204

Air pres sure: the pressing down of air, 198–200, 210–211, 219–220

An i mals: 8, 102, 247, 249; dying out of, 53, 79–85; and land changes, 80; of long ago, 50–56, 58; of long ago and of today, 56; and overcrowding, 81; and overhunting, 82–83, 88; plants and, 33–43, 50–51, 53, 56, 80, 254; and pollution, 84–85, 89; protected by people, 86–91; protecting themselves, 69–78; suited to deserts, 58–60; suited to mountains, 62–63; suited to polar regions, 60–61; suited to water, 64–65; suited to water and land, 65–68; sunlight and, 254

As tro nauts [AS-truh-NAWTS], 278

As tron o mers [hu-STRON-uh-murz], 278

Ax is [AK-suhs]: a make-believe line through the middle of a planet or the moon, 259, 261, 264, 276–277

Ba rom e ter [buh-ROM-uht-ur]: something that shows air pressure, 219–220

Be hav iour [bih-HAY-vyur]: the things a plant or an animal does, 22

Block and tack le: a machine formed by two pulleys working together, 125

Boil ing: the changing of state from a liquid to a gas, 168, 170, 175, 196

Breath ing, 29, 64–65, 152, 161–162, 172–173, 181–182, 194, 254

Burn ing: a chemical change made when oxygen joins with something that can burn, 184, 186

Car bon di ox ide [dy-OK-SYD]: the gas in the air which is made up of carbon and oxygen, and which is needed by green plants to grow, 16, 162, 181–182, 184

Cell: a tiny unit of living matter, 14–18, 29, 34, 173

Cell wall: the thick plant cell cover which gives the cell shape and lets things pass in and out of the cell, 15

Chem i cal [KEHM-ih-kuhl] **change:** the change in matter in which the molecules are changed into different kinds of molecules, 175, 181–182, 184, 186–187

Chem i cals [KEHM-ih-kuhlz]: from animals, 84, 89; harmful to animals, 73; and making rain, 224; for plant growth, 24–26

Chem ists [KEHM-uhsts]: people who study and make changes in matter, 188

Chlo ro phyll [KLOHR-uh-fihl]: the part of a plant cell which makes green plants

green and which is needed by the cell to make food, 15–16
Cir rus [SIHR-uhs]: a curly-looking cloud, 221, 223
Com pound ma chine: a machine made up of two or more simple machines, 126–131
Com put er [kuhm-PYOOT-ur]: a machine which can run other machines, 140
Com put er op er a tors, 140
Com put er pro gram mers: the people who set up computers to do work, 140
Con stel la tions [kon(t)-stuh-LAY-shuhnz]: groups of stars which make up pictures, 247–249
Cra ters: bowl-shaped holes, 266, 268, 274
Cre o sote [KREE-uh-soht]: a desert plant with roots that give off poison, 32
Cu mu lus [KYOO-myuh-luhs]: a kind of cloud, 221–222

Day: the time it takes a planet to go around its axis one time, 261–263
Di no saurs: animals that lived on the earth millions of years ago, 50–56, 58
Dis solve [dihz-OLV]: to seem to melt and disappear, 180
Dry- bulb ther mom e ter: an instrument used to help find humidity, 215

Earth: 24–25, 260; air and, 195–196; cause of seasons on, 264–265; gravity and, 133, 197; lightning and, 232; millions of years ago, 50, 53; moon and, 273–277; and other planets, 258, 266–269, 271, 273; stars and, 243, 247, 252–253; time on, 261–263; weather on, 203–204, 232–233
Elec tric i ty [ih-lehk-TRIHS-uht-ee], 253
En vi ron ment [ihn-VY-ruhn-muhnt]: surroundings, 50, 53, 58, 69–71
Evap o rat ed [ih-VAP-uh-rayt-uhd]: changed from water to water vapor, 207, 215
Evap o ra tion [ih-vap-uh-RAY-shuhn]: the change of state from a liquid to a gas, 169

Fish and wild life spe cial ist [SPEHSH-(uh-)luhst]: a person who works to help protect animals, 92
Flow er, 16, 41–42, 151–152
Food: animals and, 51, 53, 55, 58–59, 68–69, 80, 82–83, 90, 254; changed chemically, 183, 187; liquid nitrogen and, 173; made by green plants, 16, 182, 254; for plant cells, 14, 17; in seeds, 11, 19; in spores, 12, 19
Force: the strength needed to do work, 100–103, 105–108, 114–116, 122, 125, 133–136
Force arm: the part of a lever which is forced down, 114
Fore cast: to try to tell what the weather will be like, 212–213, 220
Fos sils [FOS-uhlz]: the hard parts of an animal or a plant buried in the ground and made harder by things in the soil, or the imprints made by something that lived long ago, 54–55, 57

Freez ing: the change of state from a liquid to a solid, 170, 175, 202, 208
Fric tion [FRIHK-shuhn]: the rubbing together of two things, 136–139
Ful crum: the point on which a lever rests, 114–116, 126

Gas: the state of matter in which matter has no shape of its own and does not always take up the same amount of space, 152, 160–163 / changing liquid to, 167–169; changing to liquid, 171–173; changing to solid, 174; changing solids to, 169; making up air, 16, 196–197, 254, 266; poisonous, 269–270; stars and, 243. *See also* Carbon dioxide; Nebula.
Gear: a toothed wheel of a wheel and axle machine, 121–122, 127
Gills: the parts of the body of a fish which take in oxygen from the water, 64–65
Grav i ty [GRAV-uht-ee]: the force which pulls things to the earth, 133–134, 197

Heat: animals and, 59; and the body, 206; and changing matter, 165–171, 176, 184, 186; lightning and, 234; stars and, 204, 243, 245–246, 253–254
Hu mid i ty [hyoo-MIHD-uht-ee]: the amount of water vapor in the air, 208, 215, 221
Hur ri cane [HUR-uh-KAYN]: a kind of storm with strong winds, 229–230

In clined plane: a kind of simple machine, 105–108, 133

Ju pi ter [JOO-puht-ur]: the largest planet known, 259, 263, 269–270

Leaves, 10, 12–13, 16–18, 21, 26, 29, 33–36, 38, 57, 225
Le ver: a kind of simple machine made up of a fulcrum, a load arm, and a force arm, 113–117, 122, 126
Light: and the moon, 42, 274; and planets, 257; and plants, 16, 26–27, 30, 254; and rainbows, 234; from stars, 204, 243–245, 253–254, 264
Light ning, 225, 231–234
Liq uid [LIHK-wuhd] **state:** the state of matter in which matter has no shape of its own, 152, 155–173, 179–180, 183, 202
Load arm: the part of a lever which holds something that is to be moved, 114

Ma chines: things which help make work easier, 103, 132–135, 137–139 / compound, 126–131; simple, 104–126, 137
Mars: the fourth planet out from the sun, 258, 263, 268
Mat ter: anything that takes up space, 14, 18, 150–152, 155, 163, 170, 175–179, 184
Melt ing: the changing of state from a solid to a liquid, 165–166, 169–170, 175, 180
Mer cu ry [MUR-kyuh-ree]: the closest planet to the sun, 258, 263, 266–267
Me te o rol o gists [MEET-ee-uh-ROL-uh-juhsts]: people who study weather to try to forecast it, 212–216, 219
Mi cro scope [MY-kruh-SKOHP], 14

Mi mo sa [muh-MOH-suh]: a plant which droops when touched, 34
Mol e cules [MOL-ih-KYOO(UH)LZ]: the smallest forms of matter, 150–151, 155, 158–159, 161–162, 166–167, 169–170, 175, 177–178, 180, 182–184
Moon, 267, 272–277; of Jupiter, 269

Nep tune [NEHP-T(Y)OON]: the eighth planet out from the sun, 259, 263, 270
Nim bus [NIHM-buhs]: a dark, gray rain cloud, 221–222
Ni tro gen [NY-truh-juhn]: a gas that helps make up the air, 173, 196, 233–234
Nu cle us [N(Y)OO-klee-uhs]: the part of a cell that controls its growth, 15, 18

Ox y gen [OK-sih-juhn]: a gas that living things need in order to live, 15, 19, 64, 162, 173, 181–182, 184, 196, 254, 267, 269–270

Phys i cal [FIHZ-ih-kuhl] **change:** a change in matter such as the change from one state to another, 175–179, 186
Plan ets: bodies moving around the sun that give off no light of their own, 257–263, 266–271, 273, 276. *See also* Earth.
Plant nurs ery work er, 44
Plants: 8–9, 171–172; animals and, 33–43, 50—51, 53, 56, 80; behaviour, 22—43; cell growth, 14–16, 18; growth from leaves, 21; growth from seeds, 10–11, 18; growth from spores, 10, 12–13, 18; growth from stems, 21; machines and, 129; making food, 16; needs of, 16, 26–28, 31–32, 34, 40–42, 162, 233, 254; pollution and, 84, 89; storing food, 17
Plu to [PLOOT-oh]: the farthest planet from the sun, 259, 263, 270
Pol len: a dust made by flowers and needed by them to make seeds, 41–42
Pol lut ed: unclean, 84–85, 89
Ptar mi gans [TAHR-mih-guhnz]: birds which are suited to living in a polar region, 60
Pul ley [PUL-ee]: a kind of simple machine made up of a wheel and a rope, 122–125

Rain gauge [GAYJ]: something that shows how much rain has fallen, 216
Roots, 10, 16–17, 23–25, 28, 32, 42, 234

Sat urn: a planet with three thin rings, 259, 263, 270
Screw: a kind of simple machine that can hold things together, lift things, push things, and pull things, 110–112, 127
Sea sons, 20, 129, 169, 176, 206, 208, 226, 229, 264–265, 268
Seed leaves: the parts of a seed that have food for the new plant, 10–12
Seed ing: a way of making rain or of making clouds disappear, 224
Seeds, 10–12, 14, 18–21, 23, 31, 39–41
Sol id [SOL-uhd] **state:** the state of matter in which matter has a shape of its own, 152–155, 157–166, 169–171, 173–174, 179–180

Space ships, 133, 173, 243, 266, 268, 271
Spores [SPOH(UH)RZ]: cells that some plants grow from, 10, 12–14, 18–21, 31
Stars, 242–250, 252, 255, 257–258, 260, 273. *See also* Sun.
States of matter: the three forms of matter, namely solid, liquid, and gas, 152, 163–164, 176
Stem, 10, 18, 21, 23, 25–26, 39
Stratus [STRAT-uhs]: a low flat, spread-out cloud, 221, 223
Sun, 203–204, 207, 234, 244, 251–260, 262–266, 270, 274–276
Sundial: a clock that tells time by the sun, 255–256

Thermometer [thuh(r)-MOM-uht-ur]: something used to find temperature, 202, 206, 215
Thunder, 234
Time, 255–256. *See also* Day; Sundial.
Tornado [tawr-NAYD-oh]: a kind of storm in which hot air moves up very fast in a whirl, 226–228

Uranus [yu-RAY-nuhs]: the seventh planet out from the sun, 259, 263, 270

Venus [VEE-nuhs]: the second planet out from the sun, 258, 263, 267

Water: 150, 152, 154, 207, 209; air and, 196; animals and, 52–53, 58–60, 64–68, 80, 84, 89; changing chemically, 184; changing physically, 167–169, 171–172, 174–176, 179–180, 202; clouds and, 208, 224; and gases, 161; machines and, 104, 112, 124, 135; moon and, 273; planets and, 267–270; plant cells and, 15–16; plants and, 24, 27–28, 30, 32, 34, 36, 40; pollution of, 84, 89; seeds and, 18–19; shape of, 156; spores and, 18–19; taking up space, 158; weather and, 215, 224, 226, 229
Water vapour: a gas in the air formed from water, 29, 172, 175, 196–197, 207–209, 210
Weather, 32, 169, 174, 194–195, 201–235, 264–265, 268
Weather instruments [IHN(T)-struh-muhnts], 212, 215, 217
Weather observers [uhb-ZUR-vurz]: people who study weather, 236
Wedge [WEHJ]: a kind of simple machine that can cut and push things apart, 108–109, 126–127
Wet-bulb thermometer: an instrument used to help find humidity, 215
Wheel and axle [AK-suhl]: a kind of simple machine made up of a wheel and a rod, 118–121, 127, 137
Wind chill, 206
Work: to move something through a distance, 98–109, 112–117, 119–139

Year: the time it takes a planet to go around the sun one time, 262–264
Yucca [YUHK-uh]: a plant which has flowers that stay open only one night during a year, 42

(Acknowledgments continued from page 2)

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TEACHER'S MANUAL FOR

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Contents

Introduction to THE LAIDLAW EXPLORING SCIENCE PROGRAM........T3–T6

Objectives of the program..T3
Rationale and approach......................................T3–T4
Organization and content..T4
Processes of science..T4–T5
Role of the teacher..T5–T6

Features of THE LAIDLAW EXPLORING SCIENCE PROGRAM...........T6–T9

Basic features..T6–T7
Special features..T7–T9

Teacher's Edition for THE LAIDLAW EXPLORING SCIENCE PROGRAM..T9–T12

Purpose and physical features
of the Teacher's Edition..T9
The Teacher's Manual..T9–T10
Features appearing in the extended
bottom margins..T10–T11
Features appearing in the side margins..................T11–T12

Instructional Materials..T12–T15

Unit Tests..T15–T21

Answers for Unit Tests..T22

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Introduction to
THE LAIDLAW EXPLORING SCIENCE PROGRAM

Objectives of the program

THE LAIDLAW EXPLORING SCIENCE PROGRAM has been designed and developed to provide pupils with relevant, effective learning experiences in both the knowledge and processes of science. These learning experiences are presented in such a way that all teachers can be effective teachers of science. To help you and your pupils reach these goals, the authors and editors have selected the following objectives for the program:

- ► to provide an exciting study of science by appealing to pupil interest and curiosity;
- ► to develop up-to-date science concepts and understandings that are meaningful in the lives of pupils;
- ► to provide ample opportunities for pupils to explore science through easy-to-do, "hands-on" activities utilizing familiar situations and simple, everyday materials;
- ► to help pupils become skillful in using the processes of science;
- ► to integrate skills and concepts of the biological, physical, and earth-space science areas as well as skills and concepts of other disciplines;
- ► to provide a basis for the development of positive values and attitudes toward science in people's everyday lives;
- ► to help pupils gain an awareness of the importance of their environment and its protection;
- ► to develop an awareness of career opportunities in science.

The following objectives reflect the concerns of teachers as to differences among pupils, cost and availability of materials, preparation time, and knowledge of science:

- ► to provide effective learning experiences for pupils with different interests and abilities;
- ► to utilize inexpensive materials that are common to the home or classroom for activities;
- ► to require preparation time and a background in science that are realistic for most elementary teachers.

Rationale and approach

A considerable part of the pupils' everyday life involves science in one way or another. Using this rationale, the authors and editors have approached science through situations and materials that are familiar to the pupils. Because of this approach, THE LAIDLAW EXPLORING SCIENCE PROGRAM relates to the everyday life of the pupils. The following characteristics of the program reflect this general rationale and approach:

Activity oriented. Each level of the program incorporates a "hands-on" approach using familiar, everyday materials in easy-to-do activities. In this way the pupils explore, discover, or verify concepts and ideas about objects and events. The illustrations and text material support and guide the pupils in performing and interpreting these activities.

Integrated science. The program integrates the skills and concepts of the biological sciences, physical sciences, and earth-space sciences. Because the program approaches science as part of the pupils' everyday life, multidisciplinary relationships occur naturally. Skills and concepts related to health, safety, math, music, history, art, language arts, geography, and other disciplines are integrated with science throughout the program. As a result, the pupils begin to look at the world in fresh, new ways.

Informal, highly visual style. The Laidlaw Exploring Science Program stimulates and maintains pupil interest through a direct, informal writing style and the use of full-color illustrations. The photographs and drawings have been selected not only for visual appeal but also to help explain, clarify, and provide greater insight. The informal writing style and full-color illustrations help create a program with which the teacher and pupils feel comfortable.

Use of humor. Another integral part of the rationale and approach is that a science program can be fun. Humor is effectively used to create interest and to involve pupils. For example, a cartoon based on an amusing incident is used to help introduce each unit. Humor is occasionally used to develop a concept within a unit, also.

Widening experiences. As brought out, The Laidlaw Exploring Science Program consists primarily of science which is part of the pupils' everyday life. However, the program also takes the pupils beyond this point. This is done by including certain science topics that are significant but may not be of an everyday nature. Many illustrations also serve to widen the scope of the pupils' science experiences. Because of these aspects of the program, the pupils are stimulated and aided in exploring the unknown and unusual.

Organization and content

The authors and editors have carefully structured the books to provide a consistent, functional organization which enhances effective teaching and learning. Timely and important content areas, such as the environment and its protection, are included in each book.

Units. There are six units in each book of The Laidlaw Exploring Science Program. Each unit explores a different topic of interest and importance to pupils. Balanced coverage of the life sciences, the physical sciences, and the earth-space sciences is maintained by having two units devoted to each of these three areas in each book. This carefully balanced content enables pupils to study the major areas of science every year. As pupils grow and mature from year to year, the content changes accordingly, taking into account the pupils' abilities, understandings, experiences, interests, and reading level.

The units can be studied in any order. Each unit is a self-contained teaching and learning unit. This adds a dimension of flexibility to the use of the program.

Chapters and chapter sections. Each unit is divided into chapters. The chapters aid in comprehension by breaking the unit topic into smaller teaching and learning packages.

The content of each chapter is organized by sections. The sections help outline the chapter content, further enhancing understanding of the chapters.

Processes of science

Inherent in any type of learning experience —whether it is in science, health, math, or any other area—are certain processes of learning. In science, these processes are sometimes referred to as inquiry skills.

The Laidlaw Exploring Science Program provides many opportunities for pupils to develop skill in using the processes of science. These opportunities are presented throughout the text, illustrations, and special features of the program, especially each of the "Finding Out" activities.

For ease of identification and reference, a list of these processes, or inquiry skills, and a description of each have been included on the next page.

Observing. Using the senses—seeing, tasting, touching, hearing, and smelling—to find out about objects or events in the environment

Comparing. Recognizing ways in which objects or events are alike or are different

Classifying. Grouping objects or events according to their observed characteristics

Measuring. Finding out about an unknown quantity by comparing it with a known quantity

Using numbers. Applying the operations of counting and measuring to objects or events under observation or study

Using spatial relationships. Perceiving and describing objects in terms of their shape, motion, position, or location

Communicating. Conveying information by means of oral or written descriptions, pictures, graphs, charts, maps, demonstrations, etc.

Collecting data. Combining as many processes as necessary to obtain information about objects or events

Inferring. Figuring out a conclusion based on observations of an object or event

Interpreting data. Explaining the meaning or the significance of information regarding an object or event

Predicting. Describing in advance the outcome of an event or process based on observations or data

Hypothesizing. Arriving at general statements of concepts from observations and data

Experimenting. Designing and carrying out procedures to obtain reliable information about interrelationships between objects and events

Role of the teacher

For as many teachers of science that exist, there are at least the same number of science teaching methods. A method that works for one teacher may not work for another. Therefore, to be effective, each teacher must develop his or her own method of teaching science. The pupils' text and the Teacher's Edition have been designed to support and assist you in teaching and in developing a method of teaching science which is effective and enjoyable. Some of the general ideas that follow may also be of help to you.

Inquiry techniques. When teaching science, there has been a tendency for some teachers to feel that their role was mainly to dispense knowledge and answer questions. As a result, the teachers—rather than the students—did most of the work. It is often more effective for teachers to take on a different role, one in which they facilitate pupil inquiry.

To facilitate pupil inquiry, it is important for you to create an atmosphere of exploring, investigating, and finding out. To do this, you might pose interesting objects or problems for your pupils to investigate. During investigations, you might ask key questions now and then to stimulate investigation. You might also encourage your pupils to ask questions and have them try to find answers to their questions. You and your pupils may find that some questions have many answers and that others have no answers at all! These things will help keep your science lessons interesting and open-ended.

Flexibility. Another idea which may be helpful to you in developing an effective science teaching method is to try to remain flexible. For example, you may wish to follow the sequence of units as they appear in the program. Or, you may wish to vary the sequence according to the seasons to capitalize on pupil interest or availability of materials.

In addition to using the unit-opening cartoon to introduce a unit, you may want to make use of an interesting demonstration or bulletin-board display. Another area in which being flexible is often important is the degree to which your science lessons are activity oriented. It is reasonable that you may want to make use of many activities for some lessons, but mainly use the text and illustrations for others.

To help enrich the concepts and activities in a unit, you may want to make use of community resources such as museums, factories, or parks. The possibilities are endless!

Intuition as well as logic. Another important point to keep in mind is that it is equally important for pupils to develop intuitive thought processes as well as logical thought processes. Intuitive thought processes are those processes that involve calculated guesses, hunches, and ideas such as "What would happen if I tried this?"

Most scientists agree that after all calculations have been made and all logical ideas have been pursued, it is often an intuitive process that brings the final solution to a problem. Pupils sometimes need a chance to manipulate or "play" with an object or a problem with no specific or immediate goal in mind. Pupils will often intuitively come up with questions, ideas, or solutions of their own. Through these experiences, they may begin to gain an awareness and appreciation of the aesthetics—the sheer beauty—in science.

Features of
THE LAIDLAW EXPLORING SCIENCE PROGRAM

Basic features

The features of THE LAIDLAW EXPLORING SCIENCE PROGRAM have been developed and designed to excite pupils about science by providing high interest, visual appeal, involvement, relevancy, and success for pupils. These features can be categorized as basic features which permeate the entire program or as special features designed primarily for organizing and emphasizing content and activities. This section describes the basic features of the program.

Illustrations and format. Perhaps the most obvious features of the program are the colorful illustrations and the open, uncluttered format. These two visual features create an attractive, appealing invitation to study science.

The illustrations are not only an important source for interest and appeal but they are also valuable aids to learning. Each illustration has been carefully selected for the purpose of helping to explain, clarify, add new meanings, or provide greater insight.

Many of the captions for the illustrations are in the form of inductive questions that further involve pupils in the content and in the processes of science. The many illustrations which depict children in familiar situations help pupils recognize that science is a part of their everyday life.

"You" approach. To further the pupils' feeling of involvement, the text has been written using the "you" approach. The authors and editors have written the text as if they were speaking directly to each pupil.

In-text questions. Not only does the text involve the pupils personally, but it also elicits responses from them by means of frequent questions. Most of the questions are inductive questions. They help the pupils relate their experiences and the ideas presented in the text to the total concept being developed. Some of the questions involve the pupils' opinions or feelings.

Vocabulary. The use of unfamiliar words has been kept to a minimum. However, if a word important to the understanding of a concept is unfamiliar, the word is *italicized* for emphasis and defined in the text. These words are usually followed by a phonetic respelling to aid in pronunciation and understanding.

Readability. To help ensure ease of reading, the vocabulary and sentence length in each book of the program has been controlled according to the formula that was applicable, either "The Spache Readability Formula" or the Dale-Chall "A Formula for Predicting Readability." Furthermore, extra space has been inserted between words to help ensure ease of reading.

The special consideration given the program's readability to ensure pupil success and interest is further emphasized by these previously mentioned basic features:

- a clear, direct writing style;
- illustrations that help pupils visualize topics and concepts;
- an open, pleasing format;
- a "you" approach that makes use of pupils' experiences;
- in-text questions to involve pupils;
- in-text definitions and phonetic respellings of new or difficult words.

Metric measurements (S1) are used throughout the program. Metric symbols and terminology are based on the *Metric Style Guide* and the *Metric Practice Guide.*

Special features

A variety of interesting and effective special features appear throughout the program. These special features are designed to help organize and present the content and activities of the program.

Unit introduction. A colorful, two-page introduction for each unit is designed to stimulate pupil interest and to focus on the topic of the unit.

The first page contains the unit title, chapter titles, and a colorful illustration. The illustration is made from three-dimensional artwork and carries the theme of the unit.

The second page contains an imaginative, full-color cartoon. The cartoon is followed by questions which help focus attention on the unit topic.

Chapter introduction. Each chapter begins with a brief written introduction. The introduction helps the pupils focus on the chapter topic and helps relate the chapter topic to the pupils' own experiences. Most of the written introductions are accompanied by a color illustration.

Descriptive headings. For ease of understanding, descriptive headings and subheadings are used to organize the text. The headings and subheadings appear in heavier type than the text. Many of them are written as questions or catchy phrases to add interest to the text. Also, the headings and subheadings enhance understanding and interest by dividing the text into smaller "thought packages."

"Finding Out." In THE LAIDLAW EXPLORING SCIENCE PROGRAM an activity feature, titled "Finding Out," occurs frequently throughout each book. Each of these activities provides opportunities for pupils to gain "hands-on" experiences and to use the processes of science. The concepts developed in the text are enhanced and extended through these activities.

Each "Finding Out" begins with a question that correlates the activity with a concept in the text. Next, the materials needed for the activity are listed. These consist of simple, inexpensive materials commonly found in the school or home. The simple setup is clearly illustrated and the steps for carrying out the activity are clearly and simply stated. The activity also includes questions which ask the pupils to explain their findings or relate their findings to the concept being developed. Many times, suggestions which open end the activity are also given.

A few dimensions of flexibility in this feature are of particular note. Each "Finding Out" activity has been designed so that it can be carried out by individual pupils, by small groups, or by the entire class. Substitutes for materials listed in the activity can often be used. For example, the pupils may want to use glass jars instead of milk cartons if they are more readily available or if the pupils think they will give better results. Even some of the steps can be altered to fit the situation or the interests of the pupils.

"For You to Think About." This feature appears in the side margin. It poses one or more questions which are designed to elicit the pupils' opinions or feelings about something developed in the text. Or, the pupils may be asked to make an inference, interpret data, or formulate a hypothesis regarding something developed in the text.

"Exploring on Your Own." The text often touches on many ideas that could be pursued beyond the intended scope of a unit. This special feature encourages pupils to pursue these ideas through their own research.

This feature appears in the side margin and contains a statement or two explaining a possible idea for research in connection with the corresponding text. This feature may also contain suggestions on how to carry out the research, such as doing in-depth work at the library, talking with people who use science in their jobs, or doing simple outside investigations.

"A Second Look." Each chapter ends with a short list of review questions. This feature, titled "A Second Look," enables the pupils to check their understanding of the important facts and concepts of the chapter before continuing on to the next chapter.

"Workers Who Use Science." As part of the concern for the total development of the pupils, the authors and editors have incorporated this career-oriented feature into the program. This feature appears at the end of each unit and relates and applies the main concepts of a unit to a particular field of work. This feature also describes how the work of people in this field is important to other people.

"Workers Who Use Science" contains a full-color photograph of a particular worker in action. It also includes questions about the worker and possible sources for finding answers to these questions.

The main purpose of this feature is to help create in pupils an awareness of possible career opportunities in their future. Careers which require a minimum of training are described as well as those that require college degrees.

"Reviewing the Main Ideas." The end of each unit also contains a list of the main ideas of the unit. This list provides the teacher and pupils with a handy tool for reviewing the main concepts developed in the unit.

"Reading About Science." The next feature at the end of each unit is a bibliography for the pupils. Suggestions are given for further reading about topics in the unit. The bibliography at each level offers reading materials appropriate for the age, grade level, and interests of the pupils.

"Testing for Understanding." This feature of the program provides a quick way of checking the pupils' understanding of the important ideas and words of the unit. The first part of the feature, subtitled "Ideas to Check," contains a list of statements for the pupils to designate as either true or false. The second part of the feature, subtitled "Words to Use," contains a list of incomplete statements. The pupils are asked to complete the statements using the appropriate word or words from a list of choices given.

"Having Fun with Science." This feature appears on the last page of every unit. It provides opportunities for the pupils to reinforce and extend some of the concepts of the unit by means of fun-type activities. The activities are easy to carry out and appear under many different subtitles, such as "Brainteasers," "What Am I?" "Fun with Words," and "Things to Do."

"Glossary-Index." A combined glossary and index is provided at the end of each book. The purposes of the "Glossary-Index" are to help the pupils pronounce and understand certain words in the book and to help the pupils find out about topics in the book that may interest them. The "Glossary-Index" also contains an explanation of the phonetic respelling system used in the book.

For ease of identification, the words which are listed in the "Glossary-Index" appear in boldface type. The page numbers on which the words appear are also included. Cross-references are given when considered beneficial.

Teacher's Edition for
THE LAIDLAW EXPLORING SCIENCE PROGRAM

Purpose and physical features of the Teacher's Edition

The purpose of the Teacher's Edition for THE LAIDLAW EXPLORING SCIENCE PROGRAM is to provide you, the teacher, with a variety of teaching aids which you can use conveniently and efficiently. The Teacher's Edition has been designed to help you guide your pupils in developing science concepts with ease and confidence.

The Teacher's Edition consists of full-color reproductions of each page from the pupils' text with extended bottom margins followed by a twenty-four page Teacher's Manual. The printed copy and illustrations from the pupils' text appear in the same size in the Teacher's Edition as in the pupils' text to help ensure ease of reading.

The inclusion of the pupils' pages makes it possible to easily point out something on the page for your pupils. The extended bottom margins make it possible to have a variety of specific teaching helps immediately available on the lesson page. Teaching helps which appear on the reproduced pupils' pages are printed in blue for easy identification. The Teacher's Manual contains information to help you understand and use all the components of the program effectively.

The sturdy wire binding of the book allows you to handle and use the Teacher's Edition easily and conveniently.

The Teacher's Manual

The twenty-four pages which follow the reproduced pupils' text are referred to as the Teacher's Manual. The Teacher's Manual contains information to help you understand and effectively use THE LAIDLAW EXPLORING SCIENCE PROGRAM. The Teacher's Manual consists of the sections that follow.

***Introduction to* THE LAIDLAW EXPLORING SCIENCE PROGRAM.** The objectives and approach of the program are presented with related science and science-teaching background information. Organization and content are also discussed.

Features of THE LAIDLAW EXPLORING SCIENCE PROGRAM. The features of the program are described, and the function of each feature is explained.

Teacher's Edition for THE LAIDLAW EXPLORING SCIENCE PROGRAM. Each feature of the Teacher's Edition is described. Suggestions as to how you can use each feature in teaching are explained.

Instructional Materials. This section consists of an annotated bibliography of instructional materials. The listing includes printed materials, films, and recorded materials. These instructional materials are categorized as general references or as materials appropriate for a particular unit.

Unit Tests. Suggested tests for each unit are provided in this section.

Answers for Unit Tests. Answers or sample answers for the Unit Test questions are listed in this section.

Features appearing in the extended bottom margins

A wide variety of teaching helps are conveniently located in the extended bottom margins of the Teacher's Edition.

Preparing for the unit. This feature appears on the first page of each unit. It contains page references for books, films, and recorded materials listed in the "Instructional Materials" section of the Teacher's Manual that are appropriate for use with the unit.

A list of the page reference for each "Finding Out" activity in the unit is also included. This provides an opportunity to have your pupils collect, in advance, the materials needed for each activity.

Introducing the unit. The second page of each unit contains suggestions for using the unit-opening cartoon and questions to help introduce the unit to your pupils.

Main concepts of the chapter. The main concepts of each chapter are concisely summarized on the first page of each chapter. This helps you see at a glance the main ideas to emphasize in teaching the chapter.

Performance objectives. Also appearing on the first page of each chapter is a list of performance objectives. The objectives state in behavioral terms the main things your pupils should be able to do after they have completed the learning experiences provided in the chapter. The objectives are simply stated and can be used to help establish cognitive goals with your pupils.

Important words. The important words of each chapter are also listed on the first page of each chapter. You may wish to use this list to emphasize certain words that are important in understanding the main concepts of the chapter and in strengthening science vocabulary.

Suggested activity, discussion, or research. Very often throughout a unit, suggestions for enriching a section of the pupils' text are given. These suggestions may be ideas for a simple activity, a thought-provoking discussion, or interesting research. Sometimes, a combination of suggestions is given, such as "Suggested activity and discussion" or "Suggested discussion and research."

Teaching helps for "Finding Out." This feature appears on each page that has a "Finding Out" activity. The teaching helps are divided into sections. The first section, titled "Processes used," contains a list of the science processes that your pupils will develop and utilize during the activity. A list of these processes and their description appears on page T5 of the Teacher's Manual.

Another section, "Sample findings," describes what your pupils may find out while doing the activity. Of course, your pupils' findings may go far beyond those given. However, being aware of some of the possible findings in advance can help you in guiding the pupils in their activity and discussion.

The two sections described above appear in each of the "Teaching helps for Finding Out." Two other sections which sometimes appear in this feature are "Additional information" and "Extending the Finding Out." "Additional information" may provide helpful hints for carrying out the activity. Or, it may provide background information helpful in explaining the findings. "Extending the Finding Out" contains suggestions for expanding the "Finding Out" or carrying out another activity related to the "Finding Out."

Teaching helps for pictures. The illustrations throughout each chapter are designed to help develop the concepts of the chapter. On many of the pages, specific teaching helps for using a picture are given.

Sample answers for various features. Many of the features of the program, such as "For You to Think About," are designed to elicit responses from the pupils. Of course, your pupils' responses may vary, and in many instances there are no right or wrong answers. The purposes of listing sample answers are to alert you to the kinds of answers your pupils are likely to give and to help you in guiding the discussion of the various features.

Sample answers for the following features appear in the bottom margins: questions below the unit-opening cartoon, "For You to Think About," captions for illustrations, "A Second Look," and "Workers Who Use Science." Answers for various sections of "Having Fun with Science" are given when called for.

Sample findings for "Exploring on Your Own." Also included in the bottom margins are sample findings that your pupils will most likely discover when they carry out research in the feature "Exploring on Your Own." The sample findings are designed to help you verify the pupils' findings without performing the research yourself.

Reviewing the unit. This feature appears on the first color-tinted page at the end of each unit. It encourages you to have your pupils study the list of main ideas of the unit on that page in order to review the unit and prepare for "Testing for Understanding."

For further reading. This feature also appears on the first color-tinted page at the end of each unit. It gives suggestions for encouraging your pupils to use the bibliography on that page to further explore various aspects of the unit topic.

Suggestions for evaluation. This feature appears on the same page as "Testing for Understanding" at the end of each unit. It contains suggestions for utilizing the test questions on that page for evaluating your pupils' progress. It also tells you where in the Teacher's Manual additional test questions (and their answers) for the unit can be found.

For further involvement. This feature appears on the last page of each unit. It offers suggestions for encouraging your pupils to carry out the activities in "Having Fun with Science" on that page and other fun-type activities which help reinforce some of the concepts developed in the unit.

Features appearing in the side margins

The wide side margins of the pupils' page provide space to conveniently include the teaching helps that follow.

Sample answers. Throughout the pupils' text are many questions for your pupils to think about and answer as they read the material. To help you keep a smooth flow of discussion in your classroom, sample answers to these questions are provided for you in the side margins as close to the questions as possible. Though there are often many possible answers to these questions, the sample answers are intended to alert you to the kinds of answers that are acceptable and help you keep your pupils within the main theme of the material being developed.

The questions and their corresponding answers are marked by superscript numbers for ease of identification. In the few places where there is not enough space in the side margin for sample answers, they appear in the bottom margin.

Answers for Testing for Understanding. The answers to the test questions at the end of each unit appear next to the questions. This makes it quick and easy for you to check your pupils' progress at the end of each unit.

Instructional Materials

General references

Asimov, Isaac. *Asimov's Guide to Science.* Pickering, Ontario: Fitzhenry and Whiteside, 1972.

This is a reference book filled with anecdotes about the great scientific discoveries. It has good illustrations and diagrams.

Gega, Peter C. *Science in Elementary Education,* 3rd edition. Rexdale, Ontario: John Wiley & Sons, 1977.

This book provides a comprehensive explanation of how to teach elementary science. Part I introduces science organization, strategies, evaluation, and lesson planning. Part II contains model lesson plans that encourage children to learn through the development of their own critical thinking skills.

Navarra, John Gabriel, and Zaffaroni, Joseph. *Science in the Elementary School: Content and Methods,* Downsview, Ontario: Charles E. Merrill Publishing, 1975.

This book provides content and methods for teaching science. It contains chapters on weather, space, matter, plants, and animals—all useful in presenting the topics in *Exploring Science Brown Book.*

Unit 1 Plant Growth and Behaviour (pages 6—47)

Reference materials

Elementary Science Study: Starting from Seeds. Scarborough, Ontario: McGraw-Hill Ryerson.

This book provides the teacher with helpful information and suggestions for activities that may be done in a classroom.

Fuller, Harry J., *et al. The Plant World.* Toronto, Ontario: Holt, Rinehart and Winston, 1972.

Well written and well illustrated, this book provides helpful information about plants and their habits.

Reemer, Rita. *Teaching Organic Gardening.* Toronto, Ontario: Copp Clark, 1973.

Here is an informative text with activities for even a beginning gardener or instructor on how to plan and execute an organic garden. It serves as a resource for teachers and libraries.

Filmed or recorded materials

"About Flowers," film, 7 minutes. Toronto, Ontario: National Film Board.

"Discovering Plants in the Winter," filmstrip, with record or cassette. Scarborough, Ontario: E.T.H.O.S.

"How Plants Spread and Reproduce," filmstrip, with record or tape. Agincourt, Ontario: Cinemedia.

Looking at Plants Series, "How Plants Move," 11 minutes; "How Plants Climb," 11 minutes; "How Seeds Are Made," 14½ minutes; "How Seeds Sprout," 16 minutes; films in colour. Don Mills, Ontario: Educational Film Distributors.

Plant Responses to Environmental Conditions Series, "Response to Light," "Response to Gravity," "Response to Touch," "Response to Temperature Change," filmstrips. Toronto, Ontario: Holt, Rinehart and Winston.

Unit 2 Animals and Their Environment (pages 48—95)

Reference materials

Chinery, Michael. *Concise Colour Encyclopedia of Nature.* Don Mills, Ontario: Fitzhenry and Whiteside.

This is a reference book which includes treatment of "The Animal Kingdom," "Dictionary of Animals," "Animal Behaviour," and "Prehistoric Life."

Huxley, Julian, ed. *The Atlas of World Wildlife.* Agincourt, Ontario: Gage Publishing, 1973.

This is an extensive treatment of animal life by experts in zoology, zoogeography, and conservation. It is an excellent reference for teachers and students.

Tinbergen, Niko. *Animal Behaviour.* Agincourt, Ontario: GLC Publishers, 1965.

From *Life Nature Library,* this is a beautifully illustrated study of animals and their behaviour in relation to the stimuli in their environment.

Filmed or recorded materials

"Beaverland," film, 13 minutes. Don Mills, Ontario: Educational Film Distributors.

"Discovering Animals in Winter," filmstrip, with record or tape. Scarborough, Ontario: E.T.H.O.S.

"Frog Watchers," film, 11 minutes. Don Mills, Ontario: Educational Film Distributors.

"Patterns of Survival," film. Pinegrove, Ontario: Carman Educational Associates.

"Protective Coloration," filmstrip series, with records or tapes. Agincourt, Ontario: Cinemedia.

"When Dinosaurs Ruled the Earth," filmstrip, with record. Don Mills, Ontario: Educational Film Distributors.

Unit 3 Work and Machines (pages 96—143)

Reference materials

Barker, Eric J., and Millard, W.F. *Machines and Energy.* Don Mills, Ontario: Musson, 1972.

Here is a good reference book packed with projects and experiments to be done with machines.

Elementary Science Study: Structures. Scarborough, Ontario: McGraw-Hill Ryerson.

Science 5/13 Series: Science from Toys and *Structures and Forces.* Agincourt, Ontario: GLC Publishers.

These teacher resource books have many practical and unique activities and ideas.

Filmed or recorded materials

Discovering Simple Machines Series, "Levers," "Wheels," "Inclined Plane," "Screw," sound filmstrips. Toronto, Ontario: Moreland-Latchford Productions.

"Levers," and "Making Work Easier," filmstrips, with records or cassettes. Agincourt, Ontario: Cinemedia.

Simple Machine Series, "Introduction to Levers," "Classes of Levers," "Working with Levers," "Recognizing Levers," colour films. Toronto, Ontario: Holt, Rinehart and Winston.

"Introduction to Simple Machines," colour filmstrip, 68 frames, 12 minutes. Don Mills, Ontario: Educational Film Distributors.

Unit 4 Solids, Liquids, and Gases (pages 144—191)

Reference materials

Elementary Science Study: Changes. Scarborough, Ontario: McGraw-Hill Ryerson.

This teacher guidebook has many good suggested activities.

Science 5/13: Change, Stages 1 and 2. Agincourt, Ontario: GLC Publishers, 1973.

A good teacher resource book with many interesting ideas and activities.

Filmed or recorded materials

"Solid, Liquid, Gas," Parts 1 and 2, silent films in colour. Toronto, Ontario: Holt, Rinehart and Winston.

"Heat Causes Expansion," colour film, 13 minutes. Don Mills, Ontario: Educational Film Distributors.

"Molecules in Motion," colour filmstrip. Don Mills, Ontario: Educational Film Distributors.

Unit 5 Air and Weather (pages 192—239)

Reference materials

Iger, Eve Marie. *Weather on the Move.* Don Mills, Ontario: Addison-Wesley (Canada).

Here is a well-illustrated book on how weather is made and how it is studied.

Thompson, Philip D., and O'Brien, Robert. *Weather.* Agincourt, Ontario: GLC Publishers, 1965.

From *Life Science Library,* this book is a comprehensive study of weather written for the laymen. In contains an interesting feature—a look at a thirteen-year-old's home weather station, with drawings showing how to make and use the instruments.

Filmed or recorded materials

"Air is Real," filmstrip, with record or tape. Agincourt, Ontario: Cinemedia.

Basic Weather Series, "Why Does the Wind Blow?" "Why Does the Weather Change?" "Why the Seasons?" "Why Does It Rain, Snow, Hail, and Sleet?" filmstrips with captions. Don Mills, Ontario: Educational Film Distributors.

"Storms, Hurricanes, and Tornadoes," filmstrip. Toronto, Ontario: Knowledge Aid Filmstrip House, Moreland-Latchford Productions.

"Visit to a Weather Station," filmstrip, with record or tape. Agincourt, Ontario: Cinemedia.

Unit 6 Watching the Sky (pages 240—281)

Reference materials

Moore, Patrick. *The New Guide to the Planets.* Toronto, Ontario: George J. McLeod, 1972.

This book is an up-to-date, detailed study of the planets, with copious information gathered from recent space probes.

Rosenfeld, Sam. *Science Experiments for the Space Age.* Don Mills, Ontario: Fitzhenry and Whiteside, 1972.

This book contains numerous experiments that help people understand what it is like to be on the moon, what the shape of an orbit is, whether or not the earth is turning, and many other things about the solar system.

Sagan, Carl, and Leonard, Jonathan Norton. *Planets.* Agincourt, Ontario: GLC Publishers 1966.

From *Life Science Library,* this book has entire chapters devoted to Earth, Venus, Mars, Jupiter, and the moon. It has unusual details, like shots of the earth taken from outer space which show the difficulty of detecting cities and signs of life from great distances.

Filmed or recorded materials

Junior Astronomer, "The Sky Above," "Seasons," "Day and Night," "The Family of Planets," "The Moon," filmstrips. Toronto, Ontario: Moreland-Latchford Productions.

"The Earth is a Big Turning Ball," and "The Moon: Our Neighbour in Space," filmstrips, with records or tapes. Agincourt, Ontario: Cinemedia.

"The Moon: Phases and Facts," "Solar System: Family of Planets," and "Stars Beyond the Solar System," filmstrips, with records or tapes. Don Mills, Ontario: Educational Film Distributors.

"The Planets," film, 11 minutes. Don Mills, Ontario: Educational Film Distributors.

"Satellites of the Sun," film. Toronto, Ontario: National Film Board.

Unit Tests

Purpose of the tests

Tests for each of the six units of this book are provided on the pages that follow. These tests are designed to assist you in evaluating your pupils' progress in learning and applying the important words and main concepts for each unit.

Ways of testing

Depending on your teaching approach for each unit, you might choose to use these tests to evaluate your pupils in various ways. A unit test might be used as a pretest/posttest. That is, the test might be given to your pupils before they begin a unit. Then, you might wish to give the test again after the pupils have completed the unit. In this way, you may compare the results to help you in evaluating the pupils' progress.

You might wish to use these unit tests only as posttests. After the pupils have completed a unit, you may wish to give these tests in lieu of or in addition to "Testing for Understanding" found at the end of each unit in the pupils' text.

Duplicating the tests

You are granted full permission to duplicate these tests for your classroom use. If duplicating machines are not available in your school, you are granted full permission to rewrite these tests in the form which can most easily be presented to your pupils.

Test answers

Space has been provided for answers to be written on these tests. For any short-answer or essay-type items, your pupils may need extra space to write their complete answers. For such items, you might have the pupils use the reverse side of the test or an extra sheet of paper.

Answers to each unit test are provided on the Teacher's Manual pages immediately following the last unit test. Answers to the matching, sentence completion, and true-false questions are listed numerically with their letter answer.

Answers to the essay questions are presented in a short, concise form. Your pupils' answers to these questions will, of course, vary from the exact terminology of the sample answers. It is up to your discretion to weigh each of the pupils' answers and to judge their acceptability.

Scoring the tests

Each unit test has a total score value of 100 points. The point value for each question is given with the directions for each part of the test. Some questions have a greater point value than others. By totaling the number of points for each section, you can determine the final score and record it in the space provided at the top of each test.

Name ________________________________ Score __________

(100 points total)

Test Questions for Unit 1 Plant Growth and Behaviour

(Textbook pages 6–47)

Circle the letter for each best answer. (10 points each)

1. If you turn a seed upside down,
   a. it will grow upside down.
   b. the root will turn and grow down.
   c. it won't get the oxygen it needs.
2. Seed leaves
   a. help a plant make food.
   b. make chlorophyll.
   c. store food for the growing plant.
3. Leaves turn toward light because of
   a. chlorophyll in the leaves.
   b. minerals in the soil.
   c. growth chemicals in the stem.
4. These plants grow from spores:
   a. pumpkins.
   b. ferns.
   c. peas.

Write the letter of the word or words in column II in front of the description they match in column I. (5 points each)

I

_____ 5. drowns small animals in the water it collects
_____ 6. droops when someone touches it
_____ 7. has sticky hairs to capture insects
_____ 8. causes the openings on leaves to close up
_____ 9. things a plant does
_____10. its poison keeps other plants from crowding it
_____11. keep animals from eating cactus plants
_____12. protects rosebushes from roundworms
_____13. carry pollen from one flower to another

II

a. mistletoe
b. creosote
c. pitcher plant
d. insects
e. mimosa
f. dry air
g. sundew
h. spines
i. behaviour
j. marigolds

Read the story below. Write your answer below the story. If you need more space, write on the back of this sheet or on another sheet. (15 points)

14. Jean planted radish seeds in good soil. She watered the soil every day. When the shoots appeared, Jean covered her plants with paper cups to protect the plants from her cat. Soon all the plants died. Why do you think this happened?

Name ______________________________ Score __________
(100 points total)

Test Questions for Unit 2 Animals and Their Environment

(Textbook pages 48–95)

Match what suits an animal to a certain environment in column I with the environment in column II. (6 points each)

I

-----1. has gills for breathing
-----2. never drinks water
-----3. has thick layer of fat under its skin
-----4. has cuplike hooves
-----5. has webbed feet
-----6. has feathers, even covering its feet
-----7. has thick skin to keep its body from losing water
-----8. has claws with which to hold on to ledges

II

a. mountains
b. polar region
c. desert
d. water

Write the word that best fits in each blank below. Choose from these words: *frog, turtle, elephant, duck, zebra, skunk, cheetah, opossum.* (6 points each)

9. plays "dead" as a means of defending itself ------------------------------
10. often escapes its enemies because of its speed ------------------------------
11. protects itself by withdrawing into its shell ------------------------------
12. defends itself by giving off a bad odour ------------------------------
13. has huge tusks with which to defend itself ------------------------------
14. has hooves which it uses to protect itself ------------------------------

Read the story below. Write your answer below the story. If you need more space, write on the back of this sheet or on another sheet. (16 points)

15. Ken asked Amy why she thought there were no dinosaurs in the world today. Amy said, "Because buildings took away land the dinosaurs needed for finding food." Why was Amy wrong? How would you answer Ken?

Name ______________________________ Score ____________
(100 points total)

Test Questions for Unit 3 Work and Machines

(Textbook pages 96–143)

Circle the letter for each best answer. (10 points each)

1. You can cut down on friction by
   a. putting on the brakes.
   b. oiling things which rub together.
   c. putting sand on icy roads.

2. Inclined planes help you
   a. push things apart.
   b. hold things together.
   c. use less force when moving things.

3. A wedge helps you
   a. push things apart.
   b. hold things together.
   c. overcome friction.

4. Gravity
   a. pushes things apart.
   b. holds things together.
   c. pulls things to the earth.

Write the letter of the word or words in column II in front of the description they match in column I. (5 points each)

I

_____ 5. jar top
_____ 6. seesaw
_____ 7. bicycle
_____ 8. makes something slow down or stop
_____ 9. staircase
_____10. nail
_____11. used to raise flag
_____12. wheel with teeth

II

a. gear
b. wedge
c. pulleys
d. inclined plane
e. screw
f. lever
g. friction
h. wheel and axle
i. computer

Read the story below. Write your answer below the story. If you need more space, write on the back of this sheet or on another sheet. (20 points)

13. After the kitchen floor was waxed, Mary Ann's father said, "Be careful. There's less friction when you walk on the floor now." What did he mean?

Name ______________________________ Score __________

(100 points total)

Test Questions for Unit 4 Solids, Liquids, and Gases

(Textbook pages 144–191)

Write the letter of the word or words in column II in front of the description they match in column I. (4 points each)

I	II
_____ 1. anything that takes up space	a. freezing
_____ 2. oxygen joining with iron	b. chemists
_____ 3. changing from a liquid to a solid	c. solid
_____ 4. varies in the amount of space it takes up	d. dew
_____ 5. molecules in this state are very close together	e. chemical change
_____ 6. water on leaves that comes from the air	f. dissolving
_____ 7. people who study about matter and its changes	g. melting
_____ 8. changing from a liquid to a gas	h. gas
_____ 9. changing from a solid to a liquid	i. matter
_____10. changes molecules into different kinds of molecules	j. rust
	k. boiling

Write *P* before each physical change described in the sentence below. Write *C* before each chemical change. (5 points each)

_____11. Ice cubes melt.

_____12. A match is burned.

_____13. A nail gets rusty.

_____14. You paint your bike.

_____15. You cook a potato.

_____16. Someone carves a statue out of stone.

_____17. Someone breaks a dish.

_____18. Water changes to steam.

_____19. Salt dissolves in water.

_____20. Food you eat is changed in your body.

Read the story below. Write your answer in the space below. If you need more space, write on the back of this sheet or on another sheet. (10 points)

21. Sharon left a little water in a dish overnight. The next morning it was gone. Her mother said it had evaporated. What did she mean?

____

Name ______________________________ Score __________

(100 points total)

Test Questions for Unit 5 Air and Weather

(Textbook pages 192–239)

Circle the letter for each best answer. (10 points each)

1. If the barometer is rising, you can expect
   a. fair weather.
   b. rainy weather.
   c. snowstorms.

2. Tornadoes begin in a place where the
   a. ocean and air are very hot.
   b. land and air are very hot.
   c. land and air are cold.

3. Nimbus clouds mean
   a. cool, fair weather.
   b. rainy weather.
   c. warm, fair weather.

4. Seeding clouds can cause
   a. thunder.
   b. lightning.
   c. rain.

Write the letter for the correct word or words in front of each definition in column I. Choose your answers from column II. (5 points each)

I

_____ 5. amount of water vapour in the air
_____ 6. tells how much rain has fallen
_____ 7. instrument for measuring air pressure
_____ 8. tells from which way the wind is blowing
_____ 9. receives echoes from storms in the area
_____10. sign of rain or snow
_____11. instrument for measuring temperature
_____12. people who study and forecast the weather
_____13. causes your ears to "pop" in an elevator

II

a. windchill
b. rain gauge
c. air pressure
d. barometer
e. cirrus clouds
f. meteorologists
g. radar antenna
h. weather vane
i. humidity
j. thermometer

Read the story below. Write your answer below the story. If you need more space, write on the back of this sheet or on another sheet. (15 points)

14. Kevin wanted to go on a picnic. He saw cumulus clouds in the sky. What might this have told him about the weather for the picnic ?

Name ______________________________ Score ________

(100 points total)

Test Questions for Unit 6 Watching the Sky

(Textbook pages 240–281)

Write the letter of the word in column II in front of the description it matches in column I. A letter can be used more than once. (5 points each)

I	II
----- 1. largest planet	a. Venus
----- 2. looks like a red ball	b. Jupiter
----- 3. its day is longer than its year	c. Pluto
----- 4. farthest planet from the sun	d. moon
----- 5. brightest planet in the sky	e. Mars
----- 6. moves around the earth	f. constellation
----- 7. medium-sized star	g. Saturn
----- 8. group of stars which make up a picture	h. sun
----- 9. made up of hot gases	i. Neptune
-----10. hard to see because closest to the sun	j. Mercury
-----11. Ursa Minor	

Write your answer below each of the following questions. If you need more space, write on the back of this sheet or on another sheet. (15 points each)

12. Why are stars seen only at night?

----

13. What causes daytime and nighttime?

----

14. What causes the seasons of the year?

Answers for Unit Tests

Unit 1 Plant Growth and Behavior

1. b 2. c 3. c 4. b 5. c
6. e 7. g 8. f 9. i 10. b
11. h 12. j 13. d

14. The paper cup would keep light from the plants. If plants don't have light, they can't make food. Without food, they can't grow. Soon the plants die.

Unit 2 Animals and Their Environment

1. d 2. c 3. b 4. a
5. d 6. b 7. c 8. a
9. opossum 10. cheetah 11. turtle
12. skunk 13. elephant 14. zebra

15. Amy was wrong because dinosaurs had died out before people put up buildings. Instead, the environment in which dinosaurs had lived changed. Then there wasn't enough food for them.

Unit 3 Work and Machines

1. b 2. c 3. a 4. c
5. e 6. f 7. h 8. g
9. d 10. b 11. c 12. a

13. Wax makes the floor smoother. There is less friction, or rubbing, when people walk on waxed floors than when they walk on unwaxed floors. When there is less friction, people slip and fall more easily.

Unit 4 Solids, Liquids, and Gases

1. i 2. j 3. a 4. h 5. c
6. d 7. b 8. k 9. g 10. e
11. P 12. C 13. C 14. P 15. C
16. P 17. P 18. P 19. P 20. C

21. The molecules in water are constantly moving. Some escape into the air as water vapor. When this happens, the water is said to evaporate.

Unit 5 Air and Weather

1. a 2. b 3. b 4. c 5. i
6. b 7. d 8. h 9. g 10. e
11. j 12. f 13. c

14. Cumulus clouds often mean the day will be fair and warm, without much humidity in the air—a good day for a picnic.

Unit 6 Watching the Sky

1. b 2. e 3. a 4. c 5. a
6. d 7. h 8. f 9. h 10. j
11. f

12. During the day, the light from the sun is so bright, you can't see the light from the stars. At night, when there is no sunlight, you can see the stars.

13. The earth turns on its axis. When a part of the earth is turned toward the sun, that part has daytime. When a part of the earth is turned away from the sun, that part has nighttime.

14. The earth's axis is always leaning in the same way as the earth moves around the sun; therefore, different parts of the earth lean toward the sun at different times. When the top part of the earth leans toward the sun, it gets more sunlight than the bottom part. The top part then has summer. When the top part leans away from the sun, it gets less sunlight than the bottom part. The top part then has winter.

Teacher's Notes

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MAR 19 RETURN
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